PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE.

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VOL. XXV. JANUARY TO JUNE, 1888. No. 127.

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☞ It is requested that the receipt of this number be acknowledged.

☞ In order to secure prompt attention it is requested that all correspondence be addressed simply "To the Secretaries of the American Philosophical Society, 104 S. Fifth St., Philadelphia."

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EXTRACT FROM THE BY-LAWS.

CHAPTER XII.

OF THE MAGELLANIC FUND.

SECTION 1. John Hyacinth de Magellan, in London, having in the year 1786 offered to the Society, as a donation, the sum of two hundred guineas, to be by them vested in a secure and permanent fund, to the end that the interest arising therefrom should be annually disposed of in premiums, to be adjudged by them to the author of the best discovery, or most useful invention, relating to Navigation, Astronomy, or Natural Philosophy (mere natural history only excepted); and the Society having accepted of the above donation, they hereby publish the conditions, prescribed by the donor and agreed to by the Society, upon which the said annual premiums will be awarded.

CONDITIONS OF THE MAGELLANIC PREMIUM.

1. The candidate shall send his discovery, invention or improvement, addressed to the President, or one of the Vice-Presidents of the Society, free of postage or other charges; and shall distinguish his performance by some motto, device, or other signature, at his pleasure. Together with his discovery, invention, or improvement, he shall also send a sealed letter containing the same motto, device, or signature, and subscribed with the real name and place of residence of the author.

2. Persons of any nation, sect or denomination whatever, shall be admitted as candidates for this premium.

3. No discovery, invention or improvement shall be entitled to this premium, which hath been already published, or for which the author hath been publicly rewarded elsewhere.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German, or Latin language.

5. All such communications shall be publicly read or exhibited to the Society at some stated meeting, not less than one month previous to the day of adjudication, and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with

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Stated Meeting, January 6, 1888.

Present, 22 members.

President, Mr. FRALEY, in the Chair.

Correspondence was submitted as follows: Letters accepting membership from Prof. J. Szombathy, Wien; Mr. S. Castner, Jr., Philadelphia.

Letters acknowledging receipt of diploma from Prof. J. Szombathy, Wien; Hon. Victor Duruy, Marquis de Nadaillac, Paris; Prof. Edward North, Clinton, N. Y.; Prof. Schele de Vere, University of Virginia.

Letters of envoy from the Mining Department, Melbourne; Physikalisches Central-Observatorium, St. Petersburg; Musée Guimet, Paris; Royal Observatory, Greenwich, London.

Letters of acknowledgment of receipt of Proceedings from the Geological Survey of India, Calcutta (125); Zoölogical Gardens at the Hague (125); University Library, Lund (125); Prof. Richard Akerman, Stockholm (125); R. Statistical Society, London (124, 125).

A letter from the Pennsylvania Commission on Amended Orthography, Harrisburg, calling attention to the work of the Commission, and asking the Society to assist in the examination of the defects of our orthography by the appointment of a committee or some other action.

A letter from Harvard University Observatory asking that

the deficiencies be supplied in its series of the A. P. S. publications.*

A letter from the Free Public Library, San Francisco, asking for the Society's Catalog.*

A letter from Prof. Lewis M. Haupt, acknowledging the receipt of a communication from the President of the Society informing him of the award to him of the Magellanic Premium for his paper on "The Physical Phenomena of Harbor Entrances."

A letter from the Wisconsin Historical Society requesting Part IV of the Society's Catalog.*

Accessions to the library were received from the Société Impériale des Naturalestes, Moscow; New Russia Society of Naturalists, Odessa; Comité Geologique, Physikalische Central-Observatorium, K. Akademie der Wissenschaften, St. Petersburg; Gesellschaft für Erdkunde, Berlin; Gartenbauverein, Darmstadt; Astronomische Nachrichten, Keil; Verein für Erdkunde, Zoologischer Anzeiger, Leipzig; K. Statistika Central Byrån, Stockholm; Bataviaasch Genootschap van Kunsten en Wetenschappen, Batavia; Société Batave de Philosophie Expérimentale de Rotterdam; K. Bibliotheek, 'S Gravenhage; Académie R. de Belgique, Bruxelles; Biblioteca N. Centrale di Firenze; Société Historique &c. du Cher; Académie des Sciences, Arts et Belles-Lettres de Dijon; Sociétés d'Anthropologie, d'Ethnographie, des Antiquaires, Zoologique, d'L'Enseignement Supérieur; Académie Indo-Chinoise de France, Musée Guimet, Redaction Cosmos, Ministères de la Marine et de l'Instruction Publique, Académie des Sciences de Bordeaux; Mr. Henri Moissan, Paris; Société des Antiquaires de la Morinie, St. Omer; Société de Geographie, Lisboa; Royal Society, Royal Meteorological, Astronomical, Geographical Societies, Society of Antiquarians, Greenwich Observatory, Lords Commissioners of the Admiralty, "Nature," London; Essex Institute, Salem; Yale University, "American Journal of Science," New Haven; Brooklyn Entomological Society, Brooklyn Library; Prof. E. North, Clinton, N. Y.;

* Request granted so far as practicable.

Meteorological Observatory, New York; College of Pharmacy, "Medical and Surgical Reporter," Dr. I. Minis Hays, Messrs. Thomas Hockley, Henry Phillips, Jr., Mrs. Susan I. Lesley, Philadelphia; Second Geological Survey of Penna., Harrisburg; U. S. Naval Institute, Annapolis; Director of the U.S. Mint, U.S. Government Publications, Washington, D.C.; State Board of Health, Nashville; University of California, Berkeley; Sociédad Cientifica "Antonio Alzate," Mexico; Boletin de Estadistika del Puebla; Imperial Observatorio de Rio de Janeiro.

The Committee on *Volapük* presented a supplementary report, and the original report was, on motion, read as follows:

THE Committee appointed October 21, 1887, to examine into the scientific value of *Volapük* presented the following report:

Your committee proposes first to consider the desirability of a universal language; secondly, what should be its characteristics; and, thirdly, whether that invented by the Rev. Mr. Schleyer, called by him *Volapük*, meets the requirements.

I.

That in the vastly increased rapidity of interchange of thought in modern times, some general medium of intercommunication would be welcome, is unquestioned. Wherever there are close commercial relations between nations speaking different tongues, such media are sure to arise from the necessities of daily life. Thus the Lingua Franca in the Mediterranean and "pigeon English" in the Chinese ports are dialects which have sprung out of the urgency of business needs. These mixed languages are called "jargons," and have a very high interest to the scientific linguist as illustrating the principles of the evolution of human speech. The English language is a jargon of marked type, and illustrates what was stated by W. von Humboldt early in this century, that from such crossings and mingling of tongues, are developed the most sinewy and picturesque examples of human language. This consideration shows that in adopting or framing a universal language we need not hesitate to mould it from quite diverse linguistic sources.

The presence of a number of these jargons in different parts of the world testifies to the desirability for some one simple form of discourse which could be of general adoption. Another and higher testimony to the same effect is the need now frequently and loudly expressed for a uniform terminology in the sciences. For many years it has been urged

both in this country and in Europe, that the neologisms required by the sciences be derived according to a uniform plan from the Greek, and that those heretofore obtained from Greek or Latin be brought into one general form. There is no practical difficulty about this except that which arises from the Chauvinism of some nations which are blinded by egotism or narrow notions to the welfare of the whole. Such a tendency is observable in Germany, a country once noted for its cosmopolitan sympathies. Its medical teachers, for example, have of late frequently dismissed the terms of their science derived from the Latin and Greek, in order to substitute in their place long, awkward and inharmonious Teutonic compounds. No effort at a uniform international scientific terminology can be successful if the learned in each nation be governed by national prepossessions.

Another obstacle to a universal tongue, and which at the same time is a cogent argument for the adoption of one, is the sentimental love of local dialects and forms of speech by those who have imbibed them in infancy. To-day there are active societies organized for the preservation of the Welsh, the Armorican, the Basque, the Finnish and the Flemish. For many generations nearly all learned writings in Europe were in Latin. In the eighteenth century the Latin threatened to be superseded by the French. The Transactions of Academy of Sciences of Berlin were in French ; so were the articles by the Russian professors; and in the earlier decades of the present century French prevailed in the reports of the Royal Northern Society of Antiquaries, and in most scientific publications in Slavic and Northern Teutonic countries. This is the case no longer. Every little principality claims that it should print what it has to tell the world of science in its own dialect, and claims that the world of science should learn this dialect. Thus we have on the list of our scientific exchanges publications in Roumanian and Bohemian, in Icelandic and Basque, in Swedish and Hungarian, in Armenian and modern Greek, in Japanese and in Portuguese, without counting the more familiar tongues. Even a linguist by profession, such as Max Müller, has exclaimed against the very Babel, the confusion of tongues, which exists in modern scientific literature. He has sounded an earnest appeal to the learned writers of the world to express themselves in one of the half-dozen languages which every man of wide education is supposed to read, to wit, the English, French, German, Spanish, Italian or Latin.

But even with the advantage of a well-developed international scientific terminology, it is a good deal to ask of a student of science that he should spend the time to acquire a reading knowledge of these six tongues. In many cases it is wholly impossible for lack of time. But time could always be spared to learn one language, if that were enough, particularly if this one were exceptionally simple and easy in its grammar.

Again, the commercial and traveling world demands one tongue

only, in addition of course to that which its members learn in infancy, a tongue facile to acquire, and adaptable to their peculiar wants. The time is not far off when one system of weights, measures and coinage, one division of time, one code of international law, one mode of quarantine and sanitation, one costume, will prevail throughout the civilized world, and along with this unification of action must and will come a unification of speech. It is not only desirable, it is certain to arrive, and as beings of intelligent self-consciousness, looking before as well as after, it becomes us to employ our faculties to direct the course of events so that this one universal language be not left to blind chance, but be framed and adopted of deliberate choice and with the wisest consideration.

II.

Convinced, therefore, that the time is ripe for the promulgation of a general form of speech for the civilized members of the race, we will now inquire what should be the requirements of such a tongue to merit the recommendation of this Society.

We begin by the observation that the Aryan stock is now and has been for two thousand years the standard-bearer of the civilization of the world; hence, a universal language should be based upon the general linguistic principles of that stock. In the Aryan stock the six principal living tongues in the order of their importance and extent may be ranged as follows: English, French, German, Spanish, Italian, Russian. It should be the aim of the proposed general tongue to ally itself to these somewhat in the order noted; as thus being more readily acquired by the greater number of active workers in the world at the present time.

The elements of all languages arrange themselves to the linguist under three headings—phonetics, grammar and lexicography; in other words, the vocal, the formal and the material characteristics of the tongue; and under these three headings we will sketch the traits which should make the projected universal language.

I. *Phonetics.*—We believe all will assent to the following propositions:

The orthography of the universal language should be absolutely phonetic.

Every letter in it should always have the same sound.

This sound should be one common to all the leading Aryan languages, and hence present no difficulty to a person speaking any one of them.

Diphthongs, digraphs and double consonants should all be omitted as misleading.

The meaning should never depend on tone, accent, quantity of vowels, nor rising and falling inflections of the voice. All these are inadequate and unnecessary expedients of the linguistic faculty.

The vowels should be limited to the five pure vowels: *a*, *e*, *i*,

o, *u*, pronounced as in Italian, and all impure or modified vowel sounds, as the German *ä*, *ö*, *ü*, the French *u*, the English *u* (as in *use*), *o* (as in *not*) and the neutral vowel *u* (in *but*) should be discarded. All the Aryan tongues named possess the five pure vowels, but not all the impure and neutral vowels.

In the consonantal scheme, all gutturals, aspirates, lisps and nasals should be omitted. Thus, the German *ch*, soft or hard, the Spanish *z*, the English *h* and *th*, the French *n* ; and likewise all double consonantal sounds, like the Spanish *ñ*, *ll*, *rr*, the German *kn*, *pf*, the Russian *schtsch*, the Italian *zz*, *cc*, etc., should find no place. Of all the Aryan languages the pure Castilian Spanish comes the nearest to such an ideal phoneticism, and it approaches very near indeed, a few consonantal heresies and the accent being its only drawbacks.

In the written alphabet of such a language there should be, and there would be no occasion for, any diacritical marks whatever. The so-called Latin or Roman handwriting and type should be employed, but with the omission of every sign which would require the writer to take his pen from the paper in the middle of a word, or else return to it in order to complete it. Hence the *i* should have no dot (as is the case in German) nor the *j*, and the *t* should not be crossed. No accents should be needed and no apostrophes.

The sounds of the language should not only be easy; they should also be fairly agreeable to the ear, and combinations should be sedulously avoided which in any of the leading tongues have indecorous or degrading associations.

Brevity is of great importance, and each word should be reduced to its simplest discriminative sound, consistent with sonorousness and lucidity.

II. *Lexicography.*—The vocabulary of the universal language should be based primarily on the vocabulary which is common to the leading Aryan tongues. There are 1500 words in German which are almost or quite the same in English; there are more than this number common to English, French, Italian and Spanish. A selection should be made from these similar or identical word-forms as the foundation of the lexicon. At least a thousand words in common use will be found to be the same in all these languages, when we allow for the operation of simple and well-known phonetic laws. Let the learner be taught these laws and he will at once know a good share of all the more usual terms of daily intercourse in this new language, and he will pronounce them correctly without a teacher, because it will contain no sound which is strange to his ears, and each word would be spelled as it is pronounced.

This existing common property of words, once assorted and presented in the orthography above set forth, would form one element of the lexicon; another will be those words obtained from an international

scientific terminology, to be decided upon by the committees of international congresses, appointed for that purpose.

Commercial and business terms are already largely the same, and there would be little difficulty in obtaining a consensus of opinion about them which would prevail, because it is of direct pecuniary advantage to business men to have such a uniformity.

There remain the terms in art, literature, poetry, politics, imagination, etc., to be provided for. But in the opinion of this committee it does not seem desirable at this time to urge the formation of a vocabulary which would be exhaustive. Much of it should be left to the needs of the future, as observed and guided by the international committees who should have the care and direction of the universal tongue. These committees should, by common consent, hold the same relation to it that the French Academy has, in theory at least, to the French language, enlarging and purifying it by constant and well-chosen additions. As in France, each writer would enjoy the privilege of introducing new terms, formed in accordance with the principles of the tongue, and such terms would be adopted or not, as they should recommend themselves to other writers in the same field.

III. *Grammar.*—By far the greatest difficulty is presented by the formal or grammatical features of such a proposed tongue.

We may best approach this part of our task by considering how the grammatical categories, or "parts of speech," as they are called, are treated in the various Aryan tongues, and selecting the simplest treatment, take that as our standard.

It may indeed be inquired whether in the grammar we might not profitably pass beyond the Aryan group, and seek for simpler methods in the Semitic, Turanian, African or American languages. But it is a sufficient answer to this to say that there is no linguistic process known to these remote stocks but has a parallel in some one of the Aryan dialects; and if such a process is very slightly developed in these dialects, this is probably the case because such a process has been found by experience to be unsuited to the modes of Aryan thought.

Returning to the grammatical categories or parts of speech, we find them usually classified as nine, to wit: articles, noun, pronoun, adjective, verb, adverb, preposition, conjunction, interjection.

The last of these, the interjection, is of no importance, and as for the first of them, the article, we find that the Latin and the Russian move along perfectly well without it, and hence we may dismiss it whether article definite or article indefinite, as needless in the universal language.

The adjective in Latin has gender, number and case, and in most living Aryan languages has number and gender; but in English it has neither, and, therefore, true to the cardinal principles of economy in the formal portions of speech, in the universal language it should

have neither. More than this, in colloquial English and German, and always in English in the comparative degree, there is no distinction between the adjective and the adverb; and upon this hint we perceive the inutility of the distinction and dismiss it as operose only. The comparison of adjectives should be by words equivalent to *more* and *most*, as is practically the case in the Romance languages, and never by comparative and superlative terminations, as in English and German, as our endeavor should always be to maintain the theme unchanged.

This reduces our nine parts of speech to six, which are proved to be enough, by the facts quoted.

The noun in German undergoes changes for gender, number and case. Of these the gender in all Aryan tongues except English and modern Persian, is an absurdity, without application to the object, and a most serious impediment to learners. Grammatical gender, therefore, should be absolutely dismissed, and material gender expressed by the feminine adjective of sex, as in English and most American languages (bear, she-bear, rat, she-rat, etc.).

The Greek has a singular, a dual and a plural number. The dual has dropped out of modern tongues, and in many instances the plural is grammatical only and not material. Indeed, as in most American languages, so often in English and German, the plural form is not used even when the plural number is meant. Thus, we say, ten head of steers, six dozen herring, sechszehn Stück Cigarren, sechs Uhr Abends, etc. It is probable, therefore, that both gender and number could be usually dispensed with in nouns.

With regard to the case of nouns, it will be observed that the tendency of all the Teutonic and Romance languages has been to get rid of them. French and Spanish have succeeded completely; the English retains the genitive; the German the nominative, genitive, dative and accusative, in some instances. The cases have been supplied by the use of pronouns and prepositions, and we shall be wise to respect this tendency as indicative of linguistic progress. It is historically clear that to attempt to restore the case endings of nouns would be to steer directly against the current of linguistic evolution. There has even been an effort both in English and German to dispense with the genitive by substituting a possessive pronoun for the case ending, as "John his book," "Ludwig sein Pferd;" while the Berlin dialect of the lower classes has often but one termination for both genitive and dative, where pure German has two.

The use of the possessive pronoun to indicate the genitive is simple and logical; it prevails in most American languages and most jargons; and is quite adapted to the end. In fact, some dialects, such as the French Creole of Trinidad, Martinique and St. Thomas, contain no pronominal adjectives, and make out very well by placing the personal pronoun like any other attributive case, after the noun, as *liv li*,

"his book," literally "book he." It might be queried whether the universal language would not gain in ease and simplicity by adopting this method of placement.

The dative, or *régime indirecte*, could be supplied in a similar manner by a pronoun in an oblique form. There is no necessity for more than two oblique cases of the pronoun, and they can be added to all nouns as a substitute for prepositions, when needed for clearness.

The pronouns of the modern tongues, and especially of their colloquial dialects, demonstrate that the relative, interrogative and demonstrative forms can be blended without loss of lucidity. The German *der*, the English *that*, are both relative and demonstrative; the French *qui* and *ça* are both relative and interrogative in Creole.

The reflexive pronoun is used very unnecessarily in most modern Aryan tongues. There is no logical propriety in the French *Je me casse le bras*. The use of such a form should be greatly restricted.

The verb has tense and mood, number and person. It is conjugated in all Aryan languages sometimes regularly, sometimes irregularly, and it has many forms. In studying its history, however, no one can overlook its steady tendency toward simplification of the form of the theme and the adoption of the periphrastic method of conjugation, or that by auxiliaries. By this process the verb loses all inflections and is reduced to a single form; person and number are expressed in the subject, tense and mode by auxiliaries. This should be the process adopted by the universal language, with perhaps the exception that the simple past and future might be expressed by terminations, every verb being absolutely regular. The future termination is now lost in English and German, and even the past termination is often dispensed with in both tongues, as "I give," "I did give," "ich that geben;" but as both are vigorous in the cultivated Romance tongues, these formal elements might be conceded.

A very delicate question relates to the substantive verb, "to be." Shall we omit it or express it? The Latin rarely introduces it, and there are numerous tongues in which it has no equivalent. On the other hand, modern Aryan speech has developed it markedly; the Spanish has its *ser* and *estar*, the German its *sein* and *werden*, expressive of shades of meaning included in our verb "to be." This prominence of the expressions for existence seems to be connected with marked psychological advances, and a ripening self-consciousness, as has been lately set forth by a profound French critic of language, M. Raoul de la Grasserie. We should be inclined, therefore, to respect this expression, and allow it in a universal language the prominence it enjoys in most Aryan tongues of modern type.

The prepositions offer great difficulties in modern languages. The most of them can be omitted by making all verbs which have an active meaning govern their object directly, and have the direct object follow the verb and the indirect object placed later in the sentence. The

phrase, "give to the child a spoon," would be just as intelligible in the form "give spoon child," if we remember that the direct precedes the indirect object.

The simplification of grammatical forms here proposed involves an equal simplification in syntax, and this is an enormous gain. But it involves also the loss of freedom of position, so conspicuous a feature in Latin, and by some so highly esteemed. But philosophically considered, this freedom of position is solely a rhetorical and artistic gain, not a logical superiority. Grammarians even of the classical tongues are perfectly aware that there is a fixed logical arrangement of words in a sentence, and this, and this alone, is the only arrangement which a universal language should adopt. This arrangement may be briefly given as follows: Subject before predicate; noun before its adjective; verb or adjective before qualifying adverbs, immediate object before remote object. This is the logical course of thought and should be the universal form of expression. It was a dubious advantage to the Greeks and Latins that their numerous inflections permitted them to disregard it.

Those languages which rely largely on position obtain rhetorical grace by a recognized value assigned to alterations of position; and this would apply equally to the scheme proposed.

Other questions will arise in the projecting of a universal language. Shall we adopt postpositions as well as prepositions? Shall we indicate inflections by internal vowel changes? Shall we have free recourse to affixes, suffixes and infixes? Shall we postfix conjunctions, like the Latin? Shall we manufacture entirely new roots from which to form new words and derivatives?

To all these questions your committee replies with an emphatic negative. All such processes are contrary to the spirit which has pervaded the evolution of the Aryan languages for the last two thousand years, and their adoption would violate the indicated rules for the formation of a universal Aryan speech.

III.

In applying the principles which have been above set forth to the creation of the Rev. Johann Martin Schleyer, we find something to praise and much to condemn in his attempt.

Mr. Schleyer first published a sketch of his proposed universal language in 1878, and the first edition of his grammar in 1880. It has been welcomed with applause in Germany, and efforts have been made with some success to introduce it into France, England and America.

His scheme is evidently the result of conscientious labor and thought, and he manifests a just appreciation of the needs of the time; but unfortunately the theory of construction he has adopted is in conflict with the development of both the Teutonic and Romance languages, and full of difficulties to the learner.

Beginning with its phonetics we find that he has retained the impure German modified vowels *ä*, *ö*, *ü*, the French j (*dsch*), as well as the aspirated *h* or rough breathing. He has eight vowels and nineteen consonants where five vowels and sixteen consonants should suffice; elsewhere he extends his alphabet to thirty-seven letters. He also introduces various diacritical marks indicating accent, tones, vocal inflection and quantity, all of which we consider needless and obstructive. Double consonants are numerous, and the *Volapük* is both written and printed with underscoring and italic letters, necessary to facilitate its comprehension.*

The lexicography is based largely on the English, about 40 per cent of the words being taken from that tongue, with phonetic modifications. These modifications do not regard the other Aryan languages, and various sounds of the Volapük alphabet could not be pronounced by a member of any Aryan nation without special oral teaching. This we regard as a fatal defect.

Moreover, many words are manufactured from entirely new radicals, capriciously, or even fantastically formed, and this we condemn.

The article is omitted, which is well; but the nouns are inflected through a genitive, dative and accusative case, and a plural number. The signs of these cases are respectively *a*, *e*, *i*, and of the plural *s*.

Diminutives, comparatives and superlatives are formed by prefixes and suffixes, and on the same plan adverbs are formed from adjectives, and adjectives from nouns. Thus, *silef*, silver; *silefik*, silvery; *silefikiim*, more silvery; *silefikiin*, most silvery; *silefiko*, silverly. It will be observed that while this process is not dissimilar to that once frequent in the Aryan stock, it is not analogous to that which the evolution of that stock indicates as its perfected form.

In the conjugation the subject follows the verb, *bin—ob*, I am; where *bin*=am, *ob*=I. This we object to as contrary to the logical arrangement of the proposition. We are surprised to see the German third person plural (*Sie*) retained by the author as a "courteous" form. It should be the first duty of a universal language to reject such national solecisms.

The tense is indicated by prefixes, *a*, *e*, *i*, for the imperfect, perfect, and pluperfect active, *o* and *u* for the two futures.

The passive voice has the prefix *p*, the subjunctive by the suffix *la*, the optative and imperative by the suffix *ös*, the infinitive by the suffix *ön*. Abstracts are formed by adding *äl*, as *mon*, money; *monäl*, love of money, avarice. These suffixes are to be placed in fixed relations to the root, and hence often become infixes.

The excessive multiplication of forms lends to *Volapük* an appearance totally un-Aryan. The verbal theme is modified by sixteen suf-

*These remarks are based upon the seventh edition of Schleyer's *Mittlere Grammatik der Universalsprache* Volapük (Konstanz, 1887).

fixes and fourteen prefixes. There are a "durative" tense, and a "jussive" mood, conjunctive, optative, gerund and supine forms, all indicated by added syllables, reminding one of the overloaded themes of Turanian tongues. This mechanism is not only superfluous, but if any lesson may be learned from the history of articulate speech, it is precisely the opposite to what the universal language should and must be.

The meaning is largely derived from placement, as will be seen in the following example, in which *gudikos* is the neuter adverbial noun "goodness," das Gute; *plidos*, from English "please," the third singular indicative.

Gudikòs plidös Godè.
Goodness pleases God.
Plidos Gode gudik.
It pleases God the good (the good God).
Plidös gudìk Gode.
It pleases well God.

And so on. It is acknowledged by the author that obscurities may easily arise from these transpositions, and there is much dependence on accents and tones.

From this brief comparative examination of the evolutionary tendencies of the Aryan tongues and the scheme of a universal language as offered in the works of Mr. Schleyer, it is plainly evident that the two are in absolute opposition.

Volapük is synthetic and complex; all modern dialects become more and more analytic and grammatically simple; the formal elements of Volapük are those long since discarded as outgrown by Aryan speech; its phonetics are strange in parts to every Aryan; portions of its vocabulary are made up for the occasion; and its expressions involve unavoidable obscurities. With an ardent wish for the formation and adoption of such a universal tongue, and convinced as we are that now is the time ripe for its reception, we cannot recommend Volapük as that which is suited to the needs of modern thought. On the contrary, it seems to us a distinct retrogression in linguistic progress. Nor in this day of combined activities does it appear to us likely that any one individual can so appreciate the needs of civilized nations as to frame a tongue to suit them all. Such a task should be confided to an international committee from the six or seven leading Aryan nationalities.

In conclusion, your committee would respectfully suggest that it would eminently befit the high position and long-established reputation for learning of the American Philosophical Society, to take action in this matter, without delay, and to send an official proposition to the learned societies of the world to unite in an interna-

tional committee to devise a universal language for business, epistolary, conversational and scientific purposes. As the time once was when the ancestors of all Aryans spoke the same tongue, so we believe that the period is now near when once again a unity of speech can be established, and this speech become that of man everywhere in the civilized world for the purposes herein set forth.

Your Committee therefore offers the following resolution:

Resolved, That the President of the American Philosophical Society be requested to enclose a copy of this Report to all learned bodies with which the Society is in official relations, and to such other societies and individuals as he may deem proper, with a letter asking their co-operation in perfecting an international scientific terminology, and also a language for learned, commercial and ordinary intercourse, based on the Aryan vocabulary and grammar in their simplest forms; and to that end proposing an international congress, the first meeting of which shall be held in London or Paris.

D. G. BRINTON, *Chairman*,
HENRY PHILLIPS, JR.,
MONROE B. SNYDER,
Committee.

Supplementary Report of the Committee appointed to Examine into the Scientific Value of Volapük, etc.

The former Report having been recommitted, your Committee avails itself of the opportunity to explain more clearly the aim of the previous paper, to meet some of the objections offered against particular statements, and, at the request of several members, to enlarge the scope of the Report, so as to embrace a brief consideration of the two other universal languages recently urged upon the public, the "Pasilengua" of Steiner, and the "International Language" of Samenhof.

The aim of the Committee was strongly to urge the desirability of taking immediate steps to establish a universal language, both for learned and general purposes. These steps, it asseverated, should be taken by the learned world as a body; the form of language adopted should be endorsed by the scientific societies of all nations; by their recommendation it should be introduced into schools and universities, and competent private teachers would soon make it familiar to all who would have occasion to use it. The Report distinctly states (p. 4) that it is in nowise expected that this international language will supplant any existing native tongue. It is to be learned *in addition* to the native tongue, and not *in place* of it.

The aim of the grammatical portion of the Report was simply to maintain three theses; first, that the pronunciation of the proposed tongue should be so simple that it could be learned by any one speaking

an Aryan language, without the necessity of oral instruction; secondly, that its grammar should be simplified to the utmost; and thirdly, that its lexicon should be based on the large common property of words in the Aryan tongues.

Your Committee repeats and insists that these are the indispensable requisites to any such proposed international tongue. It does not insist that the individual suggestions and recommendations contained in the report should be urged at all hazards. They were advanced rather as hints and illustrations, than as necessary conditions. Nevertheless, they were not offered hastily, and your Committee desires to refer to some of the main arguments advanced against them. This it is prepared for the better, through the complaisance of Professors Seidensticker and Easton, who have forwarded to the Committee, at its request, abstracts of their remarks.

Both these very competent critics attack the principle of deducing the grammar of the proposed language from the latest evolution of Aryan speech, to wit: the jargons. Professor Seidensticker accuses such a grammar of "poverty," and adds: "A higher organism is of necessity more complex than a lower one." Professor Easton denies that the later is the better form; or, to use his own words, "that the change from an inflected to an analytic tongue marks an advance in psychologic apprehension."

These criticisms attack a fundamental thesis of your Committee, and as they doubtless express the views of very many, they must be met.

In our opinion, they rest upon a radical misconception of the whole process of linguistic evolution. The crucial test of the development of language is that the sentence shall express the thought intended to be conveyed, and *nothing more*. When this can be attained simply by the order of words in the sentence, without changes in those words, such changes are not merely useless, they are burdensome, and impede the mind. All paradigmatic inflections, whether of nouns, adjectives or verbs, are relics of lower linguistic organization, of a barbaric condition of speech, and are thrown aside as useless lumber by the active linguistic faculty in the evolution of jargons. Compare a simple Latin sentence from Cicero with its translation into English, which is a jargon of marked type, and note how much is dropped, and with what judicious economy: *Romanis equitibus literæ afferuntur*. "Letters are brought to the Roman Knights." One word here will serve to illustrate all. In Latin the speaker must think of the adjective *Romanis* as masculine, not feminine, or neuter; as plural, not singular; as a dative, not a nominative, accusative, or vocative form; as agreeing in all these points with the noun it qualifies; and finally, as of the first, and not of the second, third, or of some irregular declension. All this needless labor is saved in the English adjective *Roman* by the method of position or placement. And so it is with every other word in this sentence. The evidence, both from theory and from history, is conclusive that

the progress of language, linguistic evolution, means the rejection of all paradigms and inflections, and the specialization of the process of placement.

Professor Easton maintains that this method (that of placement) "introduces an element of great difficulty into the language, and also doubts the acceptance of the logical order stated in the Report.

To the first of these objections the obvious answer is that the method of placement is that uniformly adopted in all jargons and mixed tongues, which is positive proof that it is the least difficult of any method of expressing relation. As to the logical order referred to by the Committee, it is surprising that any exception should be taken to it, as it is that stated in the common classical text-books.

Some related minor points remain to be noticed. In opposing vocal inflection signs and accents, on p. 5 of the Report, the Committee referred only to the written, not to the spoken language. The phonetic formation proposed is insisted upon only to the extent that no sound should be introduced which would be strange to the six leading Aryan languages. The substitution of placement for prepositions, recommended on page 9, was meant as illustrative merely. The particular statement that the Berlin dialect (of the lower class) has but one termination for both genitive and dative is upon the authority of Dr. and Mrs. Seler, of Berlin, the former a professed linguist, the latter born and raised in that city. The question whether in the German expression, *sechs Uhr Abends*, the word *Uhr* is a singular form with a plural meaning, is contradicted by Professor Seidensticker; but in view of the strictly analogous Spanish expression, *las seis horas de la tarde*, the Committee maintains its original opinion.

Passing from these specific animadversions, there were some general objections which should be answered. Various speakers maintained that the project of an international language is impossible of realization; others asserted that it was unnecessary; others that even if realized, such a tongue could have no figurative or artistic wealth of resources.

To these strictures it is replied that within eight years Volapük is claimed to have acquired one hundred thousand students; within a month it has attracted attention all over the United States; within a week a number of German merchants have announced to their foreign correspondents that in future it will be used in their business communications. If this is the case with so imperfect a language, backed by no State, no learned body, not even by the name of any distinguished scholar, what would be the progress of a tongue perfect in adaptation, and supported by all these aids to its introduction? In a decade it would be current among ten million people. That it would be barren in figurative meanings, or sterile in the expression of the loftier sentiments, is inconceivable, because, formed, though it would be, of deliberate purpose, the inherent, ever-active, linguistic faculty of the

race would at once seize upon it, enrich it, mould it, and adapt it to all the wants of man, to the expression of all his loves and hates, his passions and hopes.

Your Committee closes with a reference to the remaining two tongues now claimants for universal adoption.

The "Pasilengua" (*Gemeinsprache*, "Tongue of All") was introduced by P. Steiner, in 1885, with a small grammar and dictionary, published in German. The "International Language" of Dr. L. Samenhof, of Warsaw, is an arrival of the present year, and is explained by him in a small volume, issued in French, in his native city, under the pseudonym of "Dr. 'Esperanto."

Both these have pursued the correct path in the formation of their vocabulary; they both proceed on the plan of collecting all words common to the leading Aryan languages, changing their form as little as possible consistently with reducing them to an agreeable phoneticism, and when the same word has acquired diverse significations, selecting that which has the broadest acceptation. The plan of Dr. Samenhof is especially to be recommended in this respect, and may be offered as an excellent example of sound judgment. It is remarkable, and remarkably pleasant, to see how easy it is to acquire the vocabulary of either of these writers, and this is forcible testimony how facile it would be to secure an ample and sonorous stock of words, practically familiar to us already, for the proposed Universal Tongue.

Unfortunately, the alphabets of both employ various diacritical marks and introduce certain sounds not universal to the leading Aryan tongues. These blemishes could, however, be removed without much difficulty.

It is chiefly in the grammar that both err from the principles strenuously advocated by your present Committee. The Pasilengua has an article with three genders, *to*, *ta*, *te*, corresponding to the German *der*, *die*, *das;* it has also three case endings to the noun, besides the nominative form, which itself changes for singular and plural, masculine and feminine. In the verb the tenses are formed by suffixes, six for the indicative, four for the subjunctive; while a number of other suffixes indicate participles, gerunds, imperatives, etc.

In the same manner, Dr. Samenhof expresses the relation of the elements of the proposition in the sentence "by introducing prefixes and suffixes." "All the varying grammatical forms, the mutual relation of words to each other, are expressed by the union of invariable words" (*Langue Internationale*, p. 13). He acknowledges that this is "wholly foreign to the construction of European [he means Aryan] languages," but claims that it yields a grammar of such marvelous simplicity that the whole of it could be learned in one hour. In reality, it is what is known to linguists as the agglutinative process, and is found in the Ural-Altaic tongues, in high perfection.

It will be seen at once that the grammatic theories of both these

tongues are directly in opposition to that advocated in the present and the previous Reports. These are both distinct retrogressions to an earlier, less developed, and more cumbersome form of language than that which dispenses with paradigms and inflections of all kinds.

Nevertheless, these repeated efforts go to show that an international language is needed, that it is asked for, that it is coming, and justify the propriety of this Society, which as far back as the second decade of this century marked itself as a leader in linguistic science, taking the van in this important and living question.

After discussion, during which amendments to the resolution originally proposed by the Committee were offered by Prof. Cope and Mr. Dudley, the Society adopted the following resolution by an unanimous vote:

Resolved, That the President of the American Philosophical Society be requested to address a letter to all learned bodies with which this Society is in official relations, and to such other societies and individuals as he may deem proper, asking their coöperation in perfecting a language for learned and commercial purposes based on the Aryan vocabulary and grammar in their simplest forms; and to that end proposing an International Congress, the first meeting of which shall be held in London or Paris.

The death of Prof. F. V. Hayden was announced December 22, 1887, æt. 60, and the President was authorized to appoint a suitable person to prepare the usual obituary notice.*

The Secretaries read the report of the Judges and Clerks of the Annual Election held this afternoon for Officers and Council, stating that the following had been duly elected:

President.

Frederick Fraley.

Vice-Presidents.

E. Otis Kendall, W. S. W. Ruschenberger, J. P. Lesley.

Secretaries.

George F. Barker, Daniel G. Brinton, Henry Phillips, Jr., George H. Horn.

*Prof. J. P. Lesley subsequently appointed.

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Councilors for three years.

Aubrey H. Smith, J. Cheston Morris, Edward D. Cope, George R. Morehouse.

Curators.

Charles G. Ames, John R. Baker, Philip H. Law.

Treasurer.

J. Sergeant Price.

On motion of Mr. Dudley, Henry Phillips, Jr., was nominated for Librarian and the nominations were closed.

Prof. Philip R. Uhler, of Baltimore, read a paper on "The Albirupean formation and its nearest relatives in Maryland." In the discussion following, Prof. Lewis and Prof. Heilprin differed from the writer in their views of the age of the formations to which he referred, Prof. Lewis considering them Silurian, and Prof. Heilprin as Palæozoic and not Mesozoic.

The reading of new nominations Nos. 1173, 1174 and 1175 was postponed to the next stated meeting.

The communication from the Pennsylvania Commission on Amended Orthography was taken up, and on motion of Mr. DuBois, the President was authorized to appoint at his leisure a committee of three members to consider the subject referred to and to report the same to the Society.*

And the Society was adjourned by the President.

* Messrs. DuBois, Phillips and MacAlister subsequently appointed.

THE PHYSICAL PHENOMENA OF HARBOR ENTRANCES.

THEIR CAUSES AND REMEDIES.

DEFECTS OF PRESENT METHODS OF IMPROVEMENT.

By Lewis M. Haupt, C.E.
(Professor of Civil Engineering, University of Pennsylvania, Phila.)

This Paper was awarded the Magellanic Premium at a Stated Meeting of the American Philosophical Society, held December 16, 1887.

Every well-considered plan for improving the entrance to a harbor must take into account the existing physical conditions or features of the site, and the causes which have produced them. These features are composed of the land-drainage, the inner basin, the gorge, the outer basin, the bar and the ocean. In passing from the fresh to the salt water system, there may be one or more channels having some peculiar characteristics, which are not mere accidents, but the results of certain forces. Before any radical or permanent improvement can be effected it is necessary that the forces operating at any point should be fully understood, and, so far as possible, be measured. In tracing step by step the causes from their effects, I have found the circle of investigation unavoidably widening, until it embraced many of the physical phenomena pertaining to the North Atlantic Ocean.

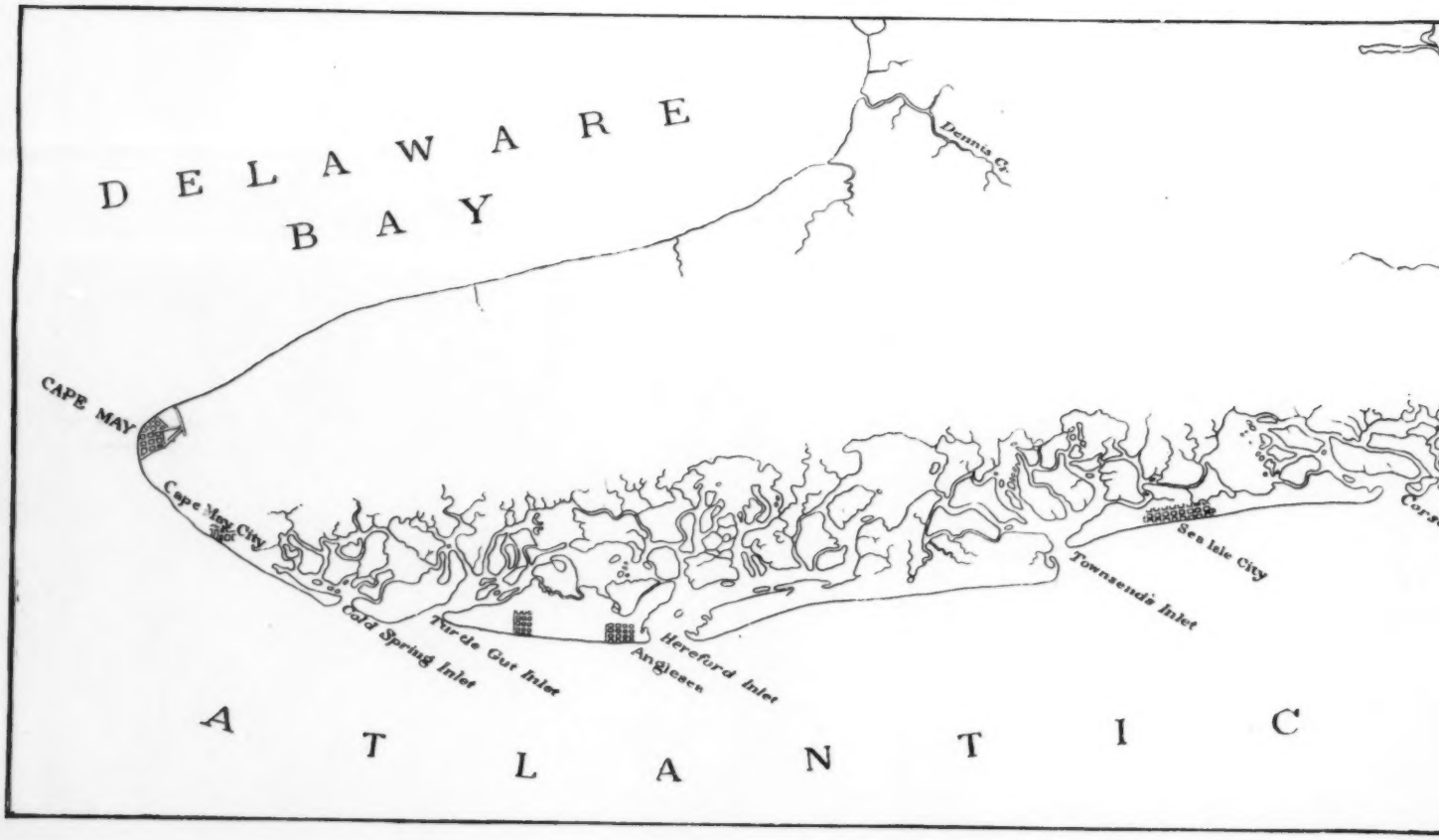
The initial point in this study is the form of the bed or mould of alluvial harbors, supposed to be of material sufficiently plastic to reveal the effect of the forces operating upon them. I have heretofore elsewhere called attention to the important deductions to be obtained from noting the position of

the submerged crest line of bars, as well as from the relative slopes of sections along the thalweg of the channel or across the bar, as indicating the direction of movement of the sand and of the flexure of the outer ends of the channels, after passing the gorge, either up or down the coast. The immediate cause of this flexure was asserted to be a littoral component which *rolled up the sand on the flood tide and compressed the ebb stream against one or other of the adjacent shores.* But why this resultant should have been so constantly operating in opposite directions at different entrances was not then fully understood or stated.

It is the object of this paper to collate certain observed facts, for the purpose of explaining these phenomena and of deducing therefrom a conclusion of practical value in the economical solution of the problem of improving our harbor entrances.

Typical Forms. (See Plate I.)

In examining the plan of any entrance it is generally found that the ends of the islands forming the outlying cordon are elongated into spits or hooks, curving inward, with a smooth outer and a rugged inner shore line; that one of the points is sharp, and the other blunt or round headed; that the sharp point usually recedes from the general coast line; that the seaward slope of a cross section of the bar is less steep than the inner slope, except where the ebb streams cross it; that the flood tide usually approaches the entrance at first in a direction more nearly parallel to the sharper lip and normal to the blunt one, rolling up the gentler slope and depositing sand on or within the crest of the bar, where "breakers" are found; that along the shore of the sharp point there is a shallow channel cut out by the flood, and curving around the blunt, projecting lip of the gorge there is the main deep-water chan-


DELAWARE
BAY
Dennis Cr.
CAPE MAY
Cape May City
Cold Spring Inlet
Turtle Gut Inlet
Hereford Inlet
Anglesea
Townsends Inlet
Sea Isle City
ATLANTIC

Great Bay
New Inlet
Brigantine Inlet
Absecon Inlet (Atlantic City Harbor)
Atlantic City
Egg Harbor Inlet
Great Egg Harbor
Ocean City
Corsons Inlet
O C E A N

nel produced by the ebb. Between these limits are found one or more secondary or swash channels, which provide egress for the lateral overflow, so to speak, of the ebb and correspond to the waste weirs or crevasses of a stream.

Charleston Harbor.

These characteristics are well illustrated in the harbor of Charleston, S. C., as seen on the chart of 1858 (Fig. 1). I have selected this early date as it shows the current movements and condition of channels before extensive improvements were begun. Here the thalweg approaches the gorge in a direction nearly east and west, and on passing out it is deflected fully 90°, and extends nearly north and south. Hugging the northern spit is the flood channel, known as Maffit's or Sullivan's Island channel, with nine (9) feet on its crest at the *inner* end. Then appear the breakers of Drunken Dick shoal, followed by the weir channels known as the North channel, with ten (10) feet at its *outer* end; the swash channel, nine (9) feet; the main ship channel, eleven (11) feet, and Lawford's channel, ten (10) feet.

The shortest distance to the outer eighteen (18) feet contour from the gorge is three and one-fourth ($3\frac{1}{4}$) statute miles, whilst by the main ship channel courses it is *seven* (7) miles, or more than double, so that vessels entering from the north must make a detour of nearly fourteen (14) miles to cross the bar.

At the only current station outside the bar the set of the flood during the first and second quarters (its most energetic period) is *parallel to the shore* of Sullivan's Island, or about west south-west, but it swings around through west to nearly north-west, or normal to the gorge during the last quarter. The stations inside of and on the bar show

local modifications of the flood and a movement towards the entrance, due to the diminution of resistance in that direction, especially during the last quarters of the flood. The plane of maximum ebb scour, as indicated by the depth of water on the bar, is limited to about twelve (12) feet.

Similar features will be noticed at Galveston (Fig. 2) and at other entrances, but it does not always happen that the crossing of the bar is so far from the gorge, nor is it always to the south. The position of this important point is the resultant of the internal and external forces which affect the movement of the main ebb stream.

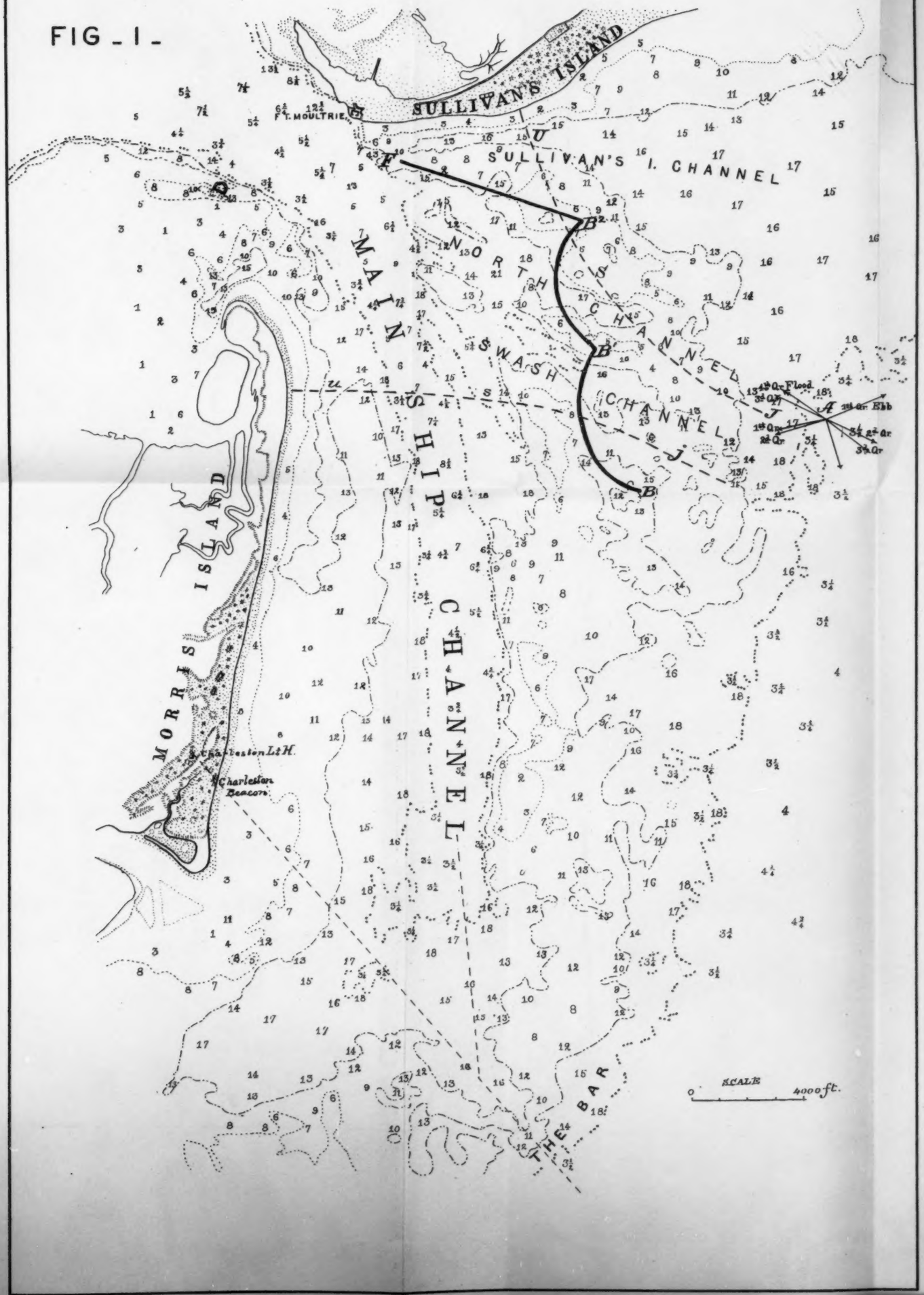
The Forces.

The *internal* forces are those resulting from the form and extent of the inner basin, the volume of the tidal prism and the relative directions of the tidal and river currents as they approach the gorge. The *external* effects are those resulting from the form, position and extent of the banks which have been piled up by the flood and obstruct the ebb. Hence it follows, if the flood pressure and movement is from the south side of the entrance the channel will be to the north, as the banks will be more extensive on the former side, offering greater resistance and deflecting the ebb stream and crowding it in until it is supported on its opposite flank by the shore. If the flood resultant comes in from the northern side, the reverse is true.

Again, if the confluent ebb streams of the inner basin are so directed by natural or artificial constructions as to commingle and unite their energies, instead of opposing one another, as most frequently occurs, the momentum of the united stream will be greater and the crossing on the bar be consequently deepened. This will be better understood by observing that the inner

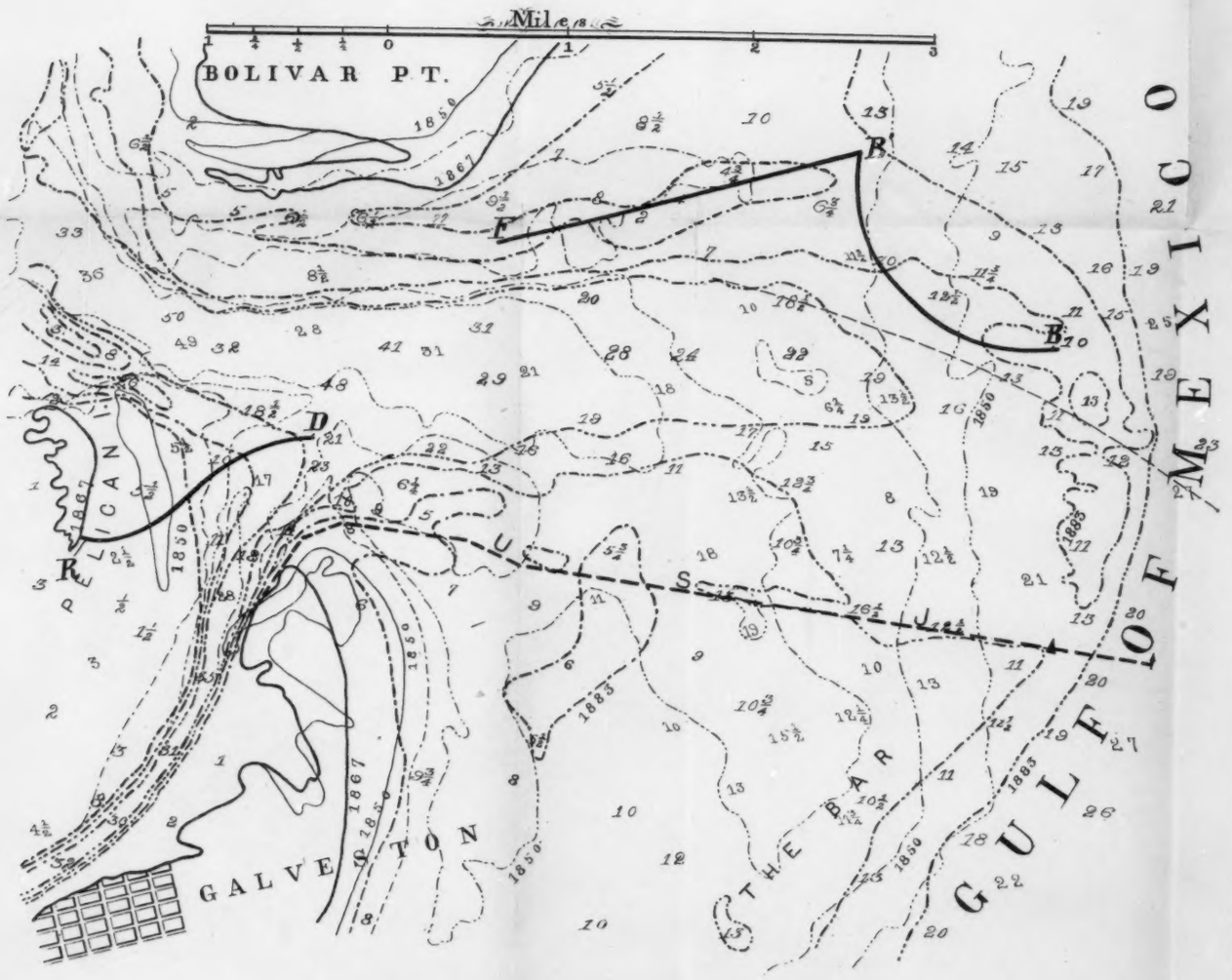
Entrance to Charleston Harbor, S.C.

FIG - I -



Entrance to Galveston Harbor, Texas.

FIG - II -



basin is generally composed of three subdivisions, viz: One extending along the islands on either hand, and one stretching to the rear. At the ebb of the tide the prisms of discharge are all approaching the gorge at the same time. In consequence of the inward flexure of the spit at this place, one or both of the lateral currents are reflected into the face of the main discharge, and thus diminish its energy, which it is the object of the engineer to conserve.

These general effects can be seen by a comparison of the position and depth of the bar crossings along the coast line of the Middle and Southern States. One of the most striking and typical instances of the effect of the internal concentration and conservation of energy is that of the *Port Royal* entrance, where there is a depth of twenty-one (21) feet on the bar, due to the increased intensity of the resultant ebb, produced by the confluence of the Beaufort, Broad and Chechessee rivers, whose thalwegs approach in directions nearly parallel. Here, too, is observed the flexure of the outer stream to the southward, showing clearly the existence of an excess of flood action from the northward, and the piling up of sand banks on this side to be eroded by the ebb.

The opposite effect resulting from conflicting internal currents is illustrated in the case of the Galveston entrance (Fig. 2).

An examination of the various entrances leaves no doubt of the existence of such a littoral flood movement, whereby the sands of the beaches are transported to and deposited in front of the inlets, where the racing waves, no longer resisted by and reflected from the shore, escape through the break in the barrier which forms the outlying sandy cordon defending the coast.

The effect of this racing of the waves in search of an escape from the pressure of the flood tide is to scour off and prolong the sharper lip at the gorge and to flatten out and beat back the opposite shore, thus shifting the position of the "inlet" until in some instances it is transported considerably to one side of the medial line of the inner bay, or entirely closed. Thus, the position of the thalweg is made to cross the gorge obliquely, and furnishes additional evidence of the resultant direction of the external or flood movement. *These movements are fully illustrated in the comparative chart herewith submitted of Barnegat Inlet (Plate IV), from which it is seen that the flood resultant comes in from the north, prolonging and eroding the northern spit compressing the ebb against the lighthouse shore, from which it has cut away so great a volume as to seriously endanger the structure. The total movement in about thirty-four (34) years has been half a mile, or about eighty (80) feet per year. Had this action been previously recognized the lighthouse would probably not have been placed in so dangerous a position, but on the north spit. During the prevailing north-east winds of this spring the encroachments have been more rapid and extensive than at any previous time. The remedy is apparent, but will be stated generally further on in this communication. The effort of the ebb is not to oppose the flood resultant directly, but to turn away therefrom and assume a direction as nearly as may be at right angles thereto.

Thus the flood will roll the sand up the gentler outer slope to the crest in a direction normal to the main channel, while the ebb will sweep across its path on the line of least resistance,

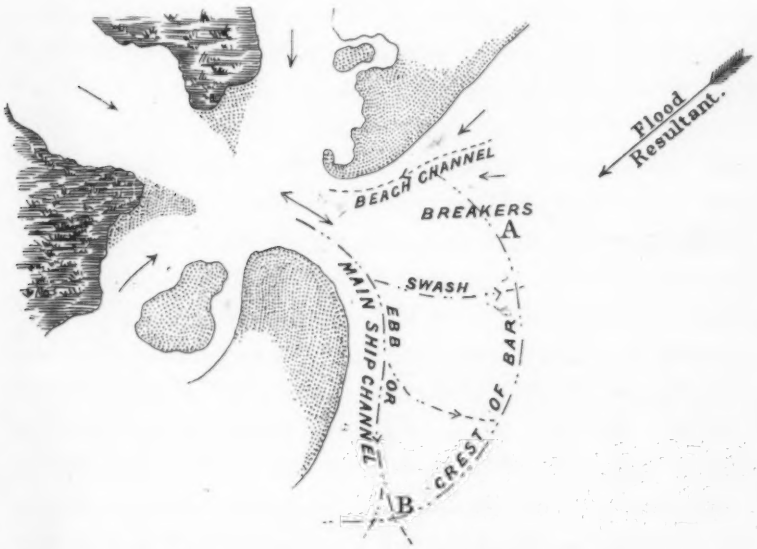
*This paragraph was interpolated here after the paper was written. See Supplement.

which lies behind and parallel to the barricade formed by the flood, and effect *its maximum result at the point of minimum resistance*, which is that point of the bar farthest removed from the direct action of the flood. This enceinte formed by the flood is also the cause of the beach channel lying under the near spit, since a portion of the flood is deflected by the bar into the re-entrant between it and the shore, whilst another portion is rolled along the beach, and these two components unite in a resultant cutting across the inner angle of the bar and carrying silt into the gorge.

The action of these forces may possibly be made clearer by reference to a simple diagram:

A. Point of maximum flood force.

B. Point of minimum flood resistance.



THE TIDAL MOVEMENTS PRODUCING THESE PHENOMENA.

Thus far I have been considering the local features, and deducing therefrom the *general condition* of the hydrodynamic

forces which have produced the observed effects. It now remains to determine why this resultant should be sometimes from the north-east and at other times from the south-east. This leads at once to an examination of the phenomena attending the approach of the tidal wave and the position of the cotidal lines with reference to the coast line. For this purpose there are available the general cotidal maps of Prof. Guyot, and the more detailed maps of Prof. Bache, accompanied by the tide tables of the Atlantic coast, as contained in the United States Coast Survey Reports. Meagre as these data are, they are yet sufficiently abundant to confirm the existence of the alleged resultant movements, and to verify in the most satisfactory manner the reliability of this method of determining the forces by their effects.

Although the phenomena of tidal movements in the open ocean are but little understood, it is well known that they are sensibly modified by the topography of the coast line.

Professor Bache says that "where a bay or indentation of the coast presents its opening favorably to the tidal wave and decreases in width from the entrance towards its head, it is well known that the tides rise higher and higher from the mouth upwards," while Lentz, in his "Ebb and Flow of the Tides," says:

"The intricate, theoretical, tide-generating conditions are complicated by a number of circumstances, forming a bewildering labyrinth of causes and results, through which the human mind cannot find its way."

"The numberless tidal waves rushing through the ocean in all directions may be compared to those formed by throwing ten (10) or twenty (20) stones into a small pond. By watching these we may learn as much as we know about the tidal waves moving on our ocean," and he adds, "this certainly is discour-

aging, and we only know that we do not know anything." While this conclusion may be true as to the currents in the open sea, it cannot be applied to those along shore, for an examination of our coast line reveals some striking and definite features. These are, the existence of four (4) prominent salients upon which the tidal crest impinges, and by which it is broken up into components, which are deflected into the bays on either side. At the points of incidence there will generally be found large inner sounds, extensive shoals and bars, and the heavy precipitation resulting from the checking of the momentum of the wave, the change in its direction and the interference and eddies produced thereby. Then follows the comparatively smooth reach of straight beach, along which the component tidal waves travel inland from the chord joining the salient capes, and finally, the indented and serrated shore where the opposing components in the same sinus meet at the point farthest from the chord, and where the tides are highest, the marshes most extensive, and the outlying cordon of sand is replaced by numerous islands and intricate "back" channels. Here the tidal wave is brought to rest, and exerts its energy in a direction nearly normal to the coast, whilst along the flanks of the bay it is moving obliquely to the shore, but always towards the bight, except when locally disturbed, and with a dynamic energy, begotten in mid-ocean, which compresses the sand upon the shores and transports it *in the direction of that motion.*

The motor in the case of the flood tide is chiefly *universal* gravitation, which raises the crest of the flood wave from two (2) to five (5) feet, and rolls it forward upon our eastern coast line until its acquired momentum is met, modified and ultimately destroyed by the inertia of the mass of sand which it encounters.

So far as the ebb is concerned, it merely rolls off from the fore-shore, chiefly under the influence of *terrestrial* gravitation, and having its initial velocity at high-water line, its transporting energy is feeble, and it, therefore, exerts no material influence in modifying the *exterior* lines of the coast.

The Southern Bay.

These generalities are more clearly exemplified and confirmed by the facts exhibited on the accompanying chart (Plate III). Beginning at Cape Florida, the heights of the tides at the various external stations are marked in feet, whilst the cotidal lines are plotted as enlarged from the United States Survey Report of 1854.

By following the coast northwardly from Cape Florida, it will be found that the height of the tide increases from 1.5 to about 7.4 feet at Jekyl Island, between St. Simon and St. Andrew's Sounds, which is the most remote point, about two hundred (200) miles, from the chord of the arc; also, that the outer ends of the main or ebb channels are flexed northwardly, and that even the land drainage extends in the same general direction. As the bight of the bay is approached, the land discharge becomes more nearly normal to the coast and the shore line more deeply indented, and after passing this point, the tidal elevations decrease (with one exception), the directions of the land and channel discharges are reversed and the shore lines become smoother. This reach of coast is characterized by three secondary bays, separated by the groins of Cape Lookout and Cape Fear. These capes are the resultants of the opposition of the tidal wave to the fresh water discharge, which being unable to effect its escape in the face of the flood is turned to the west and south by the pressure of the

tidal component deflected from Cape Hatteras. An inspection of any general map of North Carolina reveals the fact that instead of the rivers being normal to the coast, they are turned for considerable distances back from their mouths into a direction nearly parallel with the shore line, and effect their discharge under the lee of the Cape, thus *conforming to the general law of least resistance.*

The capes and bars thus formed by the parallel and confluent fresh and salt water currents deflect the littoral component until it is met by the direct flood crest and returned to the beach near the middle point of each of the three (3) bays, Raleigh's, Onslow's and Long's. Here it is resolved into secondary littoral currents along the ellipses thus formed. The eastwardly components of these waves compress the *ebb channels against the eastern shores* of the outlets, as at Beaufort, N. C., while those to the westward, reinforced by the original wave, race along the beach, closing or shoaling the inlets and forming with the land drainage the long spits above described.

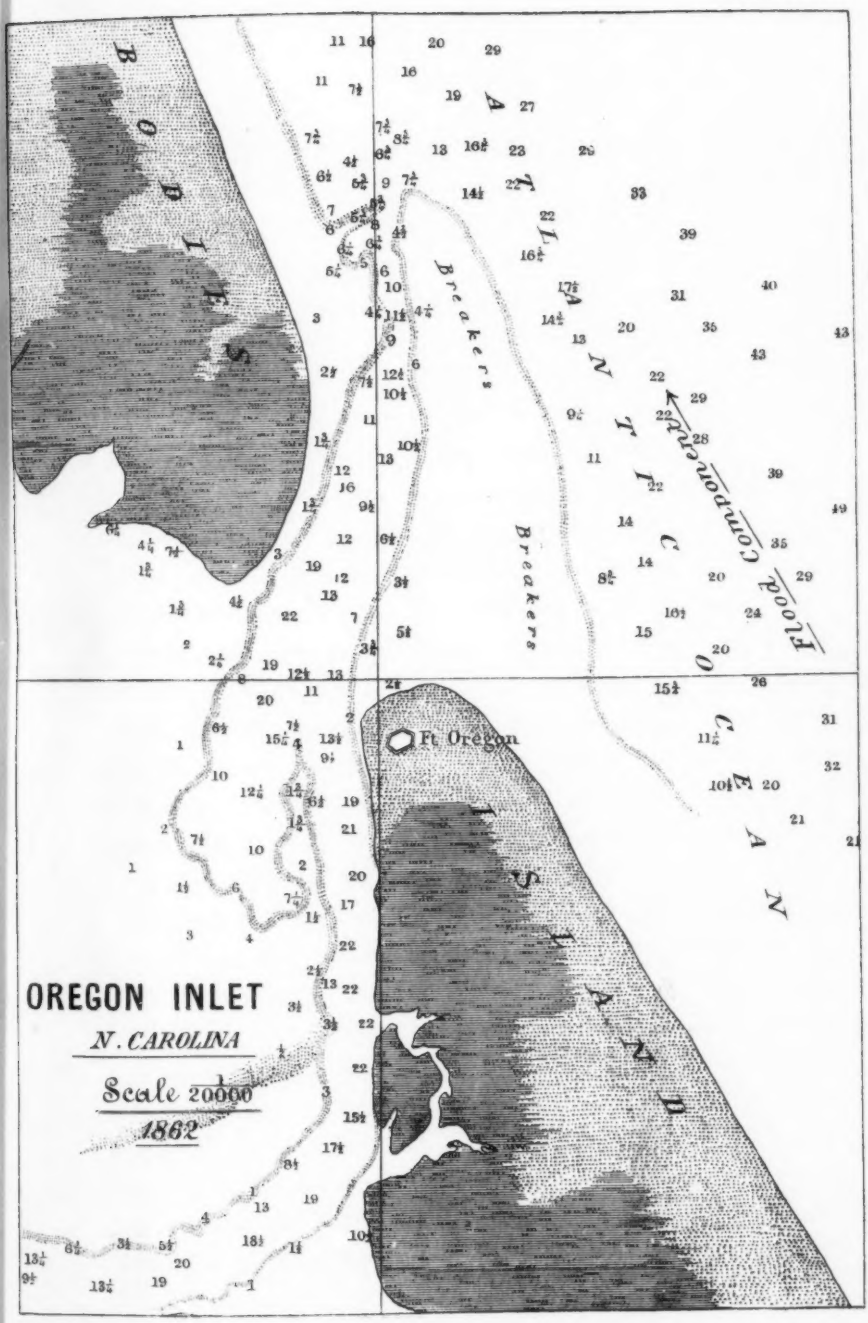
The time of high water is also much earlier outside or to the eastward of the cape than it is within, in consequence of the circuitous route required to be taken by the flood. The suction thus produced causes a draft current to the eastward, which deflects the ebb discharge from the inlets in this latter direction and increases the height of the tides inside the capes.

It is also a notable fact that a straight line drawn from Cape Roman to Hatteras is just tangent to Capes Lookout and Fear, and that the transverse and semi-conjugate axes of the ellipses of Long and Onslow Bays are respectively equal, while Raleigh Bay is somewhat smaller in both directions and has a steeper scarp than either of the others (due to the incident wave). The shore to the north of Cape Hatteras is deflected from the chord of the three bays produced at an angle of 45° for a dis-

tance of twenty-six (26) miles, when it again bends to the westward through an angle of 30°, and continues in an unbroken stretch of ninety-four (94) miles to Cape Henry. The only outlets on the eastern cordon of Hatteras are near the point of deflection where the northward component from the cape and the normal wave commingle.

The cotidal curve of eleven and one-half ($11\frac{1}{2}$) hour interval envelopes the cape in an arc of a circle whose radius is seventy-three (73) miles, whilst the shore line changes its direction through an angle of 74°. The limiting radii of this sector also pass through the main openings of the cordon at Oregon and Ocracoke Inlets, which are opposite the tangent points of the arc, and hence indicate the locus of the change of direction and weakening of the tidal wave. The coast line will also be found to be inclined to these radii at an angle of 80° which indicates the direction of the shore component at the points of intersection. At Ocracoke the chord of the bay lies 10° north of the tangent, and at Oregon (Plate II) 10° to the west, showing the movements to be east and north.

The velocity of the wave is greatest along the normal at Cape Hatteras and least along the radii limiting the sector. An examination of the interval between the cotidal lines shows also that the rate of movement of the general crest is considerably retarded as it approaches the shore. The twelve (12) hour crest will be seen with its flanks rolling along the receding shores of the bays, as already described. The earliest points of contact of the tidal wave are readily discovered from this chart to be at or near the points formerly indicated in this paper, whilst the latest point is at Jekyl's island, which is found by measurement to be just midway between Capes Florida and Hatteras, thus making the times of transit to this point of meeting of the flood components, equal.


BODIES
Breakers
Breakers
Current
Flood
Ft Oregon
OREGON INLET
N. CAROLINA
Scale 20000
1862

The Middle Bay

Extends from Cape Hatteras to Nantucket, a distance of about five hundred and forty (540) miles. Its longest ordinate is that opposite the New York entrance, where it is one hundred and forty (140) miles. The shore line from Cape Henry to Sandy Hook being nearly parallel to the chord and being broken by the two large bays of Chesapeake and Delaware, there is not so great a compression of the two converging tidal components as was observed in the southern bay, yet the same general characteristics are observable.

Proceeding north from Hatteras, there is the long sandy cordon, with its smooth beach stretching in an almost unbroken curve to Cape Henry at the mouth of the bay. Here the flood wave is interrupted and deflected by the opposing Cape Charles, the outer shore line of which is deeply scored by sounds and studded with islands and shoals, created by the flood which cushions upon it. The northern component from Cape Hatteras practically terminates here and is dissipated by the bay and the islands of the outer coast as far up as Paramores Bank. In a similar manner the component rolling westerly from Nantucket, is absorbed by Long Island Sound and New York and Raritan Bays. The normal flood wave approaching the coast on either flank of Delaware Bay is resolved by the most salient points of New Jersey and Virginia into littoral components one of which travels from a point north of Barnegat, northward to Long Island. It is this component which has created and maintained Sandy Hook and which is eroding the beach at Long Branch. (The westwardly, or Long Island component has made the spit at Coney Island, and the resultant of both, maintains the flood channel under this point.) The other or New Jersey component moves towards Cape May

and builds the bars in front of Barnegat, Absecon and other inlets, crowding the channels over against the southern shores of these inlets, which are thus eroded by the ebb currents.

The same physical features will be found to result from the components acting north and south from a point near Green Run Inlet, Md., on the coast between Cape Charles and Henlopen.

The tidal observations in this bay are indicated on the map (Plate III) and confirm this theory. The mean rise of the tide at Cape Charles is only 2.5 feet, because of the relief afforded by the bay. At Cold Spring Inlet it is 4.4, and at New York entrance 4.8. Here it attains its maximum height and thence diminishes eastwardly to Nantucket. From the secondary point of reversion near Barnegat on the New Jersey coast, the littoral currents are indicated by the heights of the tides. Thus at Barnegat they are 2 feet, at Absecon 3.9, at Cold Spring 4.4, etc.

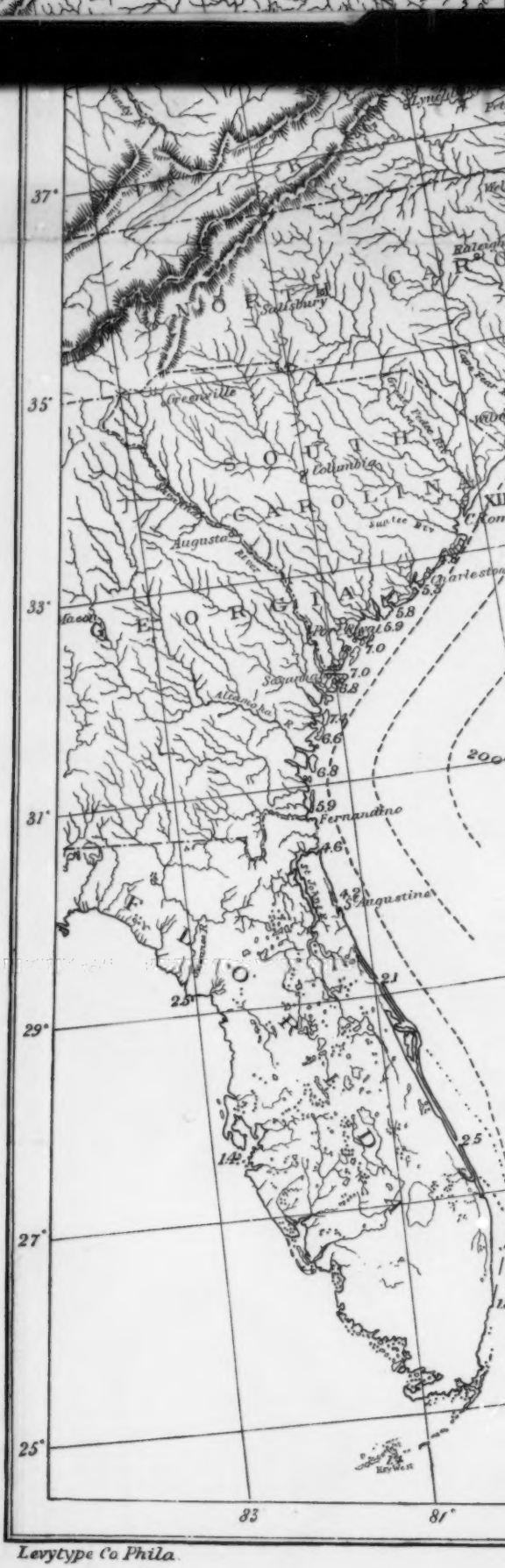
The interference of the tidal waves and the great difference of three (3) hours in the time of high water which is compressed in the short space between Martha's Vineyard and Monomoy, is too extended a subject to be included in this paper, which is intended merely for the alluvial coast line south of Long Island. Its consideration is therefore omitted, but the mean tides are recorded in part of the northern bay to illustrate the continuance of the concentration of the tidal energy and progression as previously observed.

These same laws and phenomena are found to exist on the Pacific Coast and will explain many of the effects which have only been casually noted by mariners. The phenomena are identical with those already described. The laws are of general application.

81
79°
77°
75°
73°
43°
41°
39°
37°
LAKE ONTARIO
LAKE ERIE
Rochester
Syracuse
Utica
Troy
Albany
Ithaca
Binghamton
Elmira
Williamsport
Scranton
Wilkesbarre
Reading
Philadelphia
Lancaster
Pittsburgh
Wheeling
Parkersburg
Charleston
Lynchburg
Fredericksburg
Richmond
Norfolk
Petersburg
Weldon
Wilmington
CHESAPEAKE BAY
Cleveland
Akron
Canton
Steubenville
Lancaster
Chillicothe
Big Sandy
Kanawha R.
NEW YORK
PENNSYLVANIA
OHIO
VIRGINIA
WEST VIRGINIA
DELAWARE
MARYLAND
XII
2.3
4.8
2.5
2.7

PLATE III.

73°
71°
69°
41°
39°
37°
35°
Nashua
Lowell
Salem 9.2
Boston 10
XV
XIV½
XIV
XIII
Greenfield
Springfield
Worcester 2.2
Newport 3.8
Hartford
Norwich
Providence 3.1
Plymouth 1.7
Nantucket 2.2
1.2
23
19
300
XII
21
140m
400
110
300
4.4
4.8
XII
XI½
XI
100
200
25
37
2.5
100
Oregon



Levytype Co Phila

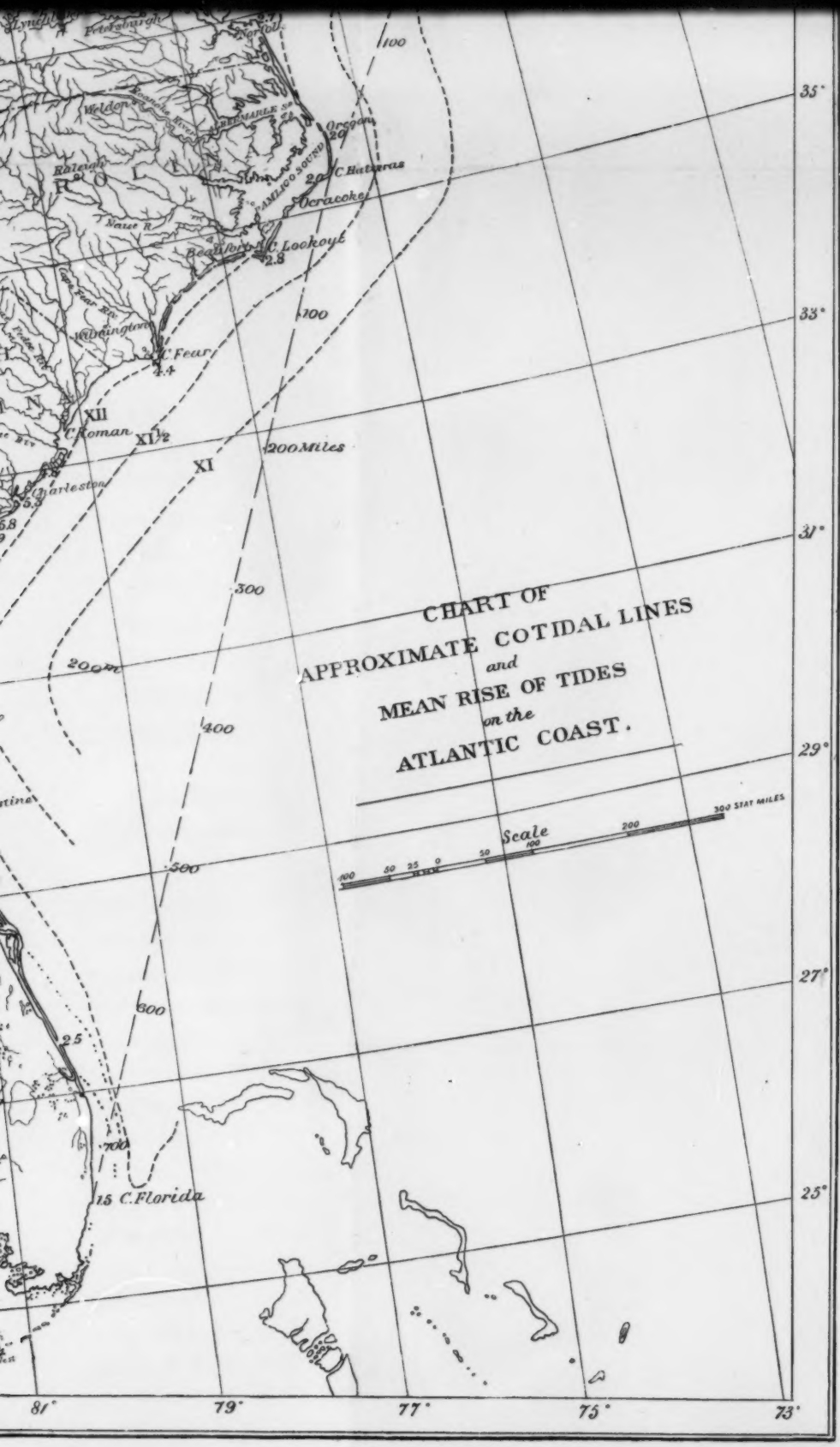


CHART OF
APPROXIMATE COTIDAL LINES
and
MEAN RISE OF TIDES
on the
ATLANTIC COAST.
Scale
300 STAT MILES
200
100
50
25
0
50
100
200
100
200
300
400
500
600
700
100
200 Miles
C. Hatteras
Ocracoke
C. Lookout
C. Fear
C. Roman
C. Florida
Charleston
Wilmington
Beaufort
Newbern
Raleigh
Weldon
Oregon
Pettigrew
Lynch
XII
XII½
XI
35°
33°
31°
29°
27°
25°
81°
79°
77°
75°
73°

The Jetty System as at Present Applied.

In applying tidal scour to the improvement of harbor entrances in the United States, these three (3) principles have been laid down as fundamental:

1. The works should be so designed that "*they should not impede the inflow to such an extent as to prevent the tidal basin being filled at every influx of the tidal wave.*"
2. "*They should control the outflow to such a degree and in such a manner that a channel of the required depth will be maintained through the bar.*"
3. "*They should not to any considerable extent, cause a movement seaward of the main body of the bar; that is, the general position of the bar should be independent of the effects produced between and beyond the heads of the jetties.*"

The attempt to reconcile these conflicting conditions as to concentration of ebb and free admission of flood resulted, after mature consideration, in a plan involving low or submerged jetties, which were tried as an experiment both at Charleston and Galveston. The result has been to push the body of the bar seaward, without at the same time materially deepening the water on its crest. The cost of these experiments has reached nearly $3,000,000.

These plans are defective, not only in their failure to depress the plane of tidal scour over the bar, but they are so designed as to divert the ebb stream directly into the face of the flood, where the resistance to be overcome is the greatest. The plans for Galveston have been modified, and it is now proposed to raise the jetties to high water, at an estimated cost at this port alone of $7,000,000. But even if this be done upon the two

lines as proposed, there will still be the serious violation of the first of the above established principles, and the further serious objection of directing this diminished tidal prism into the face of the flood, near its point of maximum energy, with nothing to lower the plane of tidal scour except the small amount of head due to contraction. This is in violation of the accepted rule that all works designed for river or harbor improvements should aid, rather than oppose, nature. To turn an ebb stream out of its natural bed and deflect it by jetties across a bar is to impose additional resistance; first, from the change of direction, and second, from the additional resistance opposed by the higher crest and steeper slope of the bar. There is also a less effective relative area of ingress due to the form of the converging jetties.

Unless there is a large augmentation of the tidal prism by land drainage or from some other source during the epoch of the flood, such works will not, in general, prove beneficial. The location of the mouth of the jetties and the general design of the works is evidence that the principles enunciated in this paper as to the action of the flood and ebb forces have not been, as yet, fully appreciated in the planning of works of this description. The South Pass jetties are subjected to totally different conditions, as the flood tide furnishes but a very small percentage of the ebb discharge.

General Requirements for Harbor Improvements.

From what has already been presented as to the origin of the bars and the relations that exist between the flood and ebb resultants, it must be evident that the engineer who proposes to aid nature must so design his *external* works as to *prevent the flood tide from carrying sand into the channel* to obstruct

the ebb and require more work of it for its removal. He should also see that *the ebb be not diverted from its course, but be protected and defended* by a line of detached breakwaters. This will further have the effect of *confining the ebb waters*, which would otherwise escape in the swash or weir channels, to the main stream, *and so concentrate their energy upon a single point of the bar, and that point the one where the bar-building forces are the weakest.*

This barricade should *not in general be joined to the beach at the shore end*, but there should be left a wide opening across that portion of the bar which corresponds to the flood or beach channel. This should be deepened by the concentration of the flood currents, and the sand carried through the gorge would make fast land inside of the spit. Its quantity could be regulated by the extent of the opening. Thus the tendency of the flood to build its own barrier upon which to break would be aided, and the ebb would be protected in its escape. It also appears that but one such line of breakwater would in general be required, and hence the cost would be materially reduced. As it would occupy a site already dangerous to vessels, it would not increase the risks to navigation, but on the contrary, as it would project above the surface, it would be a beacon as well as a breakwater, and would greatly diminish the difficulties of effecting an entrance by sailing vessels over the case of a double line of extended jetties with a narrow pass between them, especially if submerged.

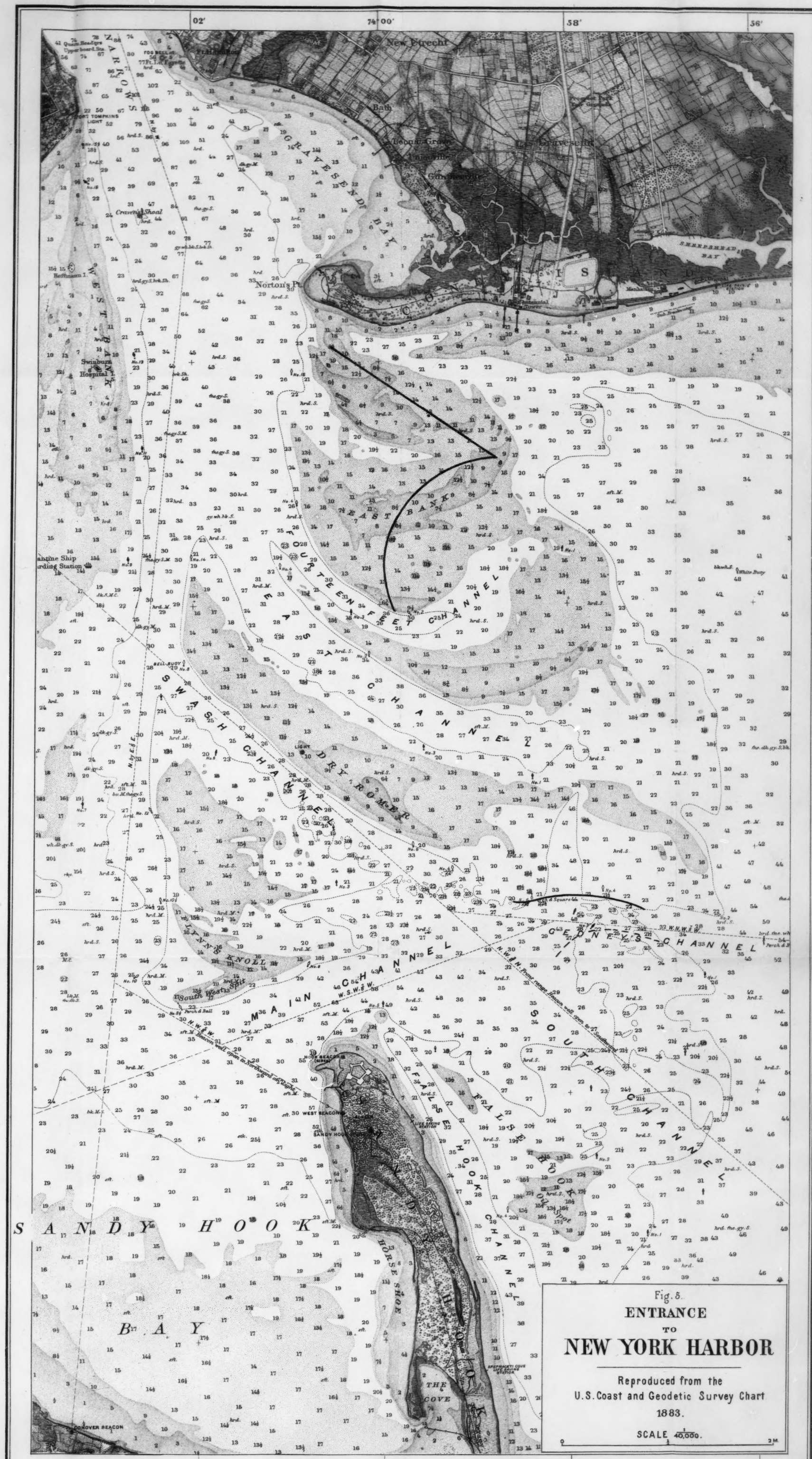
Internal Projects.

In connection with these external works there will be required in certain harbors regulating deflectors, or reaction dikes, to prevent the current interferences which produce hummocks, mounds, and even islands just inside the entrances

The position, extent and character of these works will depend largely upon the form and extent of the inner basin. Both the outer and inner lines should be so adjusted as not seriously to check the prevailing currents, nor produce shoals where they might be injurious to navigation.

The General Plan.

A typical plan for a breakwater which will not produce eddies or objectionable shoals, nor be eaten away by the sea, would be one composed of curves whose cusps are pointed in the direction of the advancing flood resultant, and having an inshore flank to concentrate the flood upon the beach channel, where it is both possible and desirable to maintain one. The curves should have the semi-conjugate diameters equal to about one-fourth ($\frac{1}{4}$) of the transverse. The interferences resulting from this *form* will produce shoals in front of the groins, thus reinforcing them, and as the outer end of the breakwater is pointed so as to receive the flood point blank, there will be no eddy nor any abrupt checking of its velocity inside to cause shoaling, yet the flood will be freely admitted and there will be a circulation created by having the beach end open. During the ebb there is no interference with the main current, but there is a concentration of its energy upon the weaker portion of the bar. For an illustration of this plan reference is made to the location on the chart of Charleston (Fig. 1), submitted herewith. The jetties, U. S. J. now under contract, cover a total length of six (6) miles. Those projected, of but three (3) miles, and the latter will make two (2) good channels, one for flood and one for ebb, while it is very doubtful whether the former will produce any material improvement of the entrance, but it will advance the general shore line and push the bar further to seaward.



F. Moras lith. Phil.

The combination of this external barricade against the sand with the internal reaction dike for current concentration is shown in the chart of Galveston Harbor (Fig. 2), where the general direction of the movement is illustrated by the comparative shore lines and by the sand caught and held in the former channel by the south jetty. At the New York entrance (Fig. 5) similar effects are observed. Here the flood is compressed under the shore of Coney Island, where the beach channel is found, while the various ebb channels wind over the bar to the southward, increasing in depth as they approach Sandy Hook. The phenomenally deep basin on the bar at the head of Gedney's Channel is also seen. The plans as proposed for utilizing the existing natural forces for increasing the scour without obstructing any of the channels, are indicated by the heavy lines on the chart.

The Breakwater.

Jetties as now constructed are frequently composed of riprap stone of small dimensions, which lose nearly half of their weight when immersed. Hence they are easily displaced, and the work disintegrates. At Galveston the brush and stone jetties shrank or subsided during construction *61* per cent. The plans of the author propose to overcome this serious defect by constructing the breakwater of béton or other material constructed in barges, or on floats in the back channels, whereby the resistance of large masses will be rapidly secured to oppose the flood and protect the ebb. But the details of this method of construction do not properly constitute a part of this discovery. What is claimed as meritorious in this communication, and upon which the judgment of the Society is desired, is:

1. The determination of the character, direction and relative intensities of the forces acting upon any harbor entrance, from a study of the submerged topography and other local physical features.
2. The discovery of the existence of typical forms in the sandy spits bordering the entrance, which will in general indicate the direction of the resultant movement.
3. The recognition of the fact that the proper place for the ebb discharge, or channel over the bar, is as far removed as may be from the point of direct attack of the flood resultant, when the direction of the latter is not normal to the coast.
4. The definite enunciation of the principle that the trend of the coast with reference to the cotidal line will in general indicate at once the proper position for defensive works.
5. The presentation of an original form (in plan) of breakwater, whereby the natural agencies are materially *aided*, without serious interference with either the flood or ebb forces.
6. A method of improvement whereby the *internal* currents are concentrated and conserved for more efficient scour after passing the gorge.
7. A plan for utilizing the natural tendencies of the flood to cut a beach channel which shall be available for the lighter draught vessels.
8. The enunciation of the principle that the cause of the angular movement of the ebb stream after egress is due to the general form of the exterior coast line, which causes a racing of the tidal crests, from the outer capes towards the bight of the bay, and that the *flood components thus generated are the principal forces* which build the bars and shift the inlets. This incessant semi-diurnal action of the flood is *the controlling element* in the forces affecting

the magnitude and position of the bar. Storms and winds may modify and shift the deposits, but eventually the flood re-establishes the original conditions.

9. The free circulation and ingress given to the flood by the detached breakwater, so designed as both to oppose a portion of the flood and produce interfering waves which deposit sand outside of the channel whilst it also aids the ebb in its attack on the bar by defending its channel and concentrating its volume.

10. For a given site and stage of water the flood movement approaches in the *same direction*, hence the resisting and regulating works should be placed on the near side of the proposed channel. If on the far side, they would be worse than useless, unless for shore protection.

11. No artificial re-opening of an outlet which has been closed by this flood component, can be maintained without auxiliary works to deflect and modify its action. Dredging is only justified when the interests of navigation are sufficient to maintain a continuance of the expense and no other reasonable methods are available.

12. The ability resulting from these general principles to construct works requiring a lesser linear development which will produce greater navigable depths at less cost.

13. The abolition of the risks and difficulties attending the navigation of narrow jetty entrances in times of danger.

14. It frequently happens that the requirements of navigation and tidal concentration are conflicting, the former demanding wide entrances, the latter, on account of insufficient tidal volume, narrow ones. This debars the usual jetties and prevents improvement. The plans herein proposed are eminently adapted to meet such exigencies. As, for example, at Absecon Inlet.

Such being some of the practical results which it is claimed must follow from the discovery of the general direction and mode of action of the flood tide upon harbor inlets, an intelligent application of the principles should result in improving commercial intercourse, reducing the risks of navigation, lowering the rates of freight and insurance, and cheapening the cost of the construction of such works to the general government.

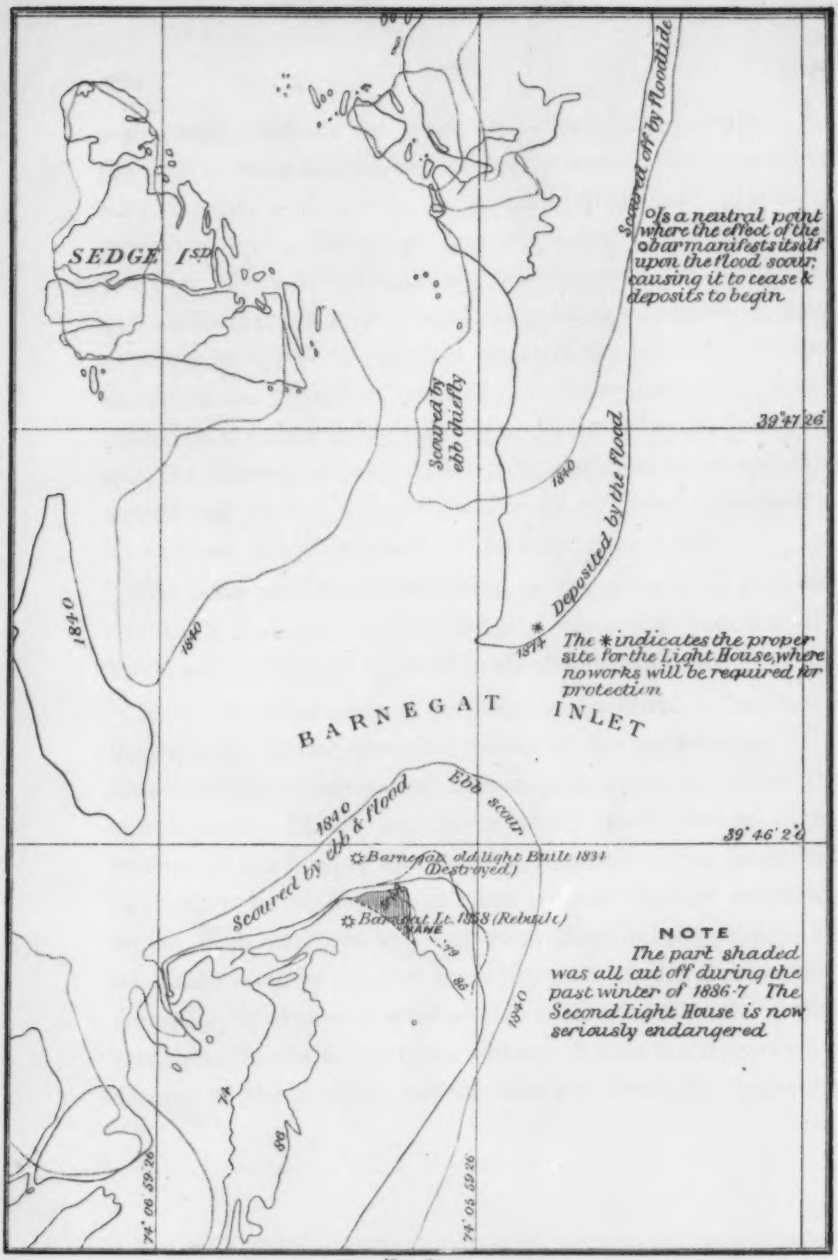
All of which is respectfully submitted for your consideration in compliance with a requirement of the By-Laws governing applications requiring an impartial but searching investigation.

Supplement to the Paper on the Physical Phenomena, Etc.

Since writing the above paper, I have seen and made a copy of a comparative survey chart of Barnegat Inlet, which so fully sustains the theory of the cause and direction of the movement and shows so conclusively the practical value of such knowledge that it is submitted herewith as additional information. The notes on the tracing, excepting the date of the surveys, are my own. They will sufficiently explain the directions of the movements without further elaboration.

It appears from this chart, that the lighthouse erected in 1834 was destroyed by the encroachments of the sea, presumably just prior to the construction of its successor in 1858. This would give an average rate of scour on the *inner* beach of thirty (30) feet per year, due to the retarded flood and ebb currents at this point.

To protect the present structure, which was placed about eight hundred (800) feet to the south, three (3) or more jetties


SEDGE Isd.
Scoured by ebb chiefly
Scoured off by flood tide
Is a neutral point where the effect of the ebb manifests itself upon the flood scour; causing it to cease & deposits to begin
39°47'26"
1840
Deposited by the flood
1874
The * indicates the proper site for the Light House, where no works will be required for protection
BARNEGAT INLET
1840
Ebb scour
Scoured by ebb & flood
39°46'26"
Barnegat old light Built 1834 (Destroyed)
Barnegat Lt. 1858 (Rebuilt)
NOTE
The part shaded was all cut off during the past winter of 1886-7 The Second Light House is now seriously endangered
74°08'26"
74°09'26"
Scale
FEET 5000 4000 3000 2000 1000 500 0
1 Statute mile

were constructed on the beach to deflect these currents. As the ends of these structures were nearly normal to the currents, they created eddies, were soon undermined and gradually swallowed up by the sea, so that at present but a short stub remains. Thus these auxiliary works prove but temporary and ineffectual. Money is continually being expended in futile attempts to oppose the onward march of the sea which declines either to be flanked or resisted by shore-protection works placed on the obstructing spit. By a change of base to the north spit, the interests of navigation would, doubtless, be as well subserved and all the defensive works be rendered unnecessary. The proper site is indicated on the tracing by a star.

The same conditions existed but a few years since at Absecon Inlet, and they are continually recurring wherever the lights are on the spit opposed to the flood resultant.

So far as permanency of location is concerned, it becomes a very simple matter therefore to select the proper site. The local interests of navigation may require it to be nearer the ebb channel. If, however, the flood or beach channel is improved by the form of breakwater proposed in this paper, the light may be placed on or just in rear of this structure, which from its *form* will not scour deep holes to undermine its flanks, as they do not cross the path of the flood or ebb normally, or even at a considerable angle, and thus the ability readily to locate a lighthouse where it will not be eroded, is another of the practical benefits resulting from this discovery.

PROC. AMER. PHILOS. SOC. XXV. 127. F. PRINTED FEB. 21, 1888.

The Albirupean Formation and its nearest relatives in Maryland.

By P. R. Uhler.

(*Read before the American Philosophical Society, January 6th, 1888.*)

Near the mouth of the Patapsco river, almost in the path of its ship channel, and at a distance of nearly one mile from the nearest shore of Rock creek, there projects above the surface of the water a huge pile of compact siliceous rock. This conspicuous body of sandstone has been an object of interest to mariners and tourists ever since the entrance to the harbor of Baltimore was first discovered. Almost from the first settlement of the region this island of stone has been called the "White Rocks." This name was given to it because of the white color which it presents when seen from the channel of the river in clear daylight; and the plural term, rocks, has reference to the several masses into which the island has been split by natural agencies. No accurate description of this remarkable object has yet been published, and as it is directly connected with one of the great geological features of Maryland, it deserves to be particularly noticed.

This white quartzite now forms fragments of the great sand-belt which crosses Chesapeake bay from the vicinity of Elkton in Cecil county, and runs in a south-west direction to beyond the great Patuxent river and grades into the low hills before reaching the East branch of the Potomac river. Eleven miles north-north-east of the city of Baltimore, it constitutes an extensive superficial bed, projecting two or three feet above the surface of the sandy loam, exposed over more than half an acre in extent. At this point it is broken into blocks and chunks, is largely composed of pebbly conglomerate (the pebbles often angular in form), and extends down fully ten feet into the sandy loam. South-east of this point for a distance of three miles or more, the same variety of rock has been reached at a depth of twenty to twenty-five feet in the excavations made for wells.

The next point where this quartzite may be seen is about eleven miles farther southeast. There much of the rock has an exceedingly dense texture. It lies in a broad sloping sheet dipping about ten degrees towards the east-south-east, and appears to be about twelve feet in thickness. This sheet of rock runs beneath tidewater at the mouth of Back river, and seems to cover nearly an acre in superficial extent.

About one mile farther to the west and up the Back river a continuation of this bed makes its appearance on the sloping shore.

The rock next appears in North Point creek about five miles farther southward, still maintaining the same compact texture. From this place, however, much of it has been removed, because of its obstruction to navigation.

Three miles distant, across the channel in the Patapsco river, we reach the island of stone alluded to at the beginning.

Here we see three oblong masses of sandstone rock, each more than thirty feet in length, separated by a few feet of water, the more superficial parts of which are a dense quartzite, rising like cliffs ten or twelve feet above high tide, and dipping from twenty to thirty degrees eastwardly. This is not the common dip of the undisturbed members of this series, and probably points to the exercise of tremendous energy in displacing a body of rock more than twenty-five feet thick, which at the bottom of the water, even now, covers more than a square acre in extent.

The two masses lying farthest to the north and east are more generally impregnated with ferric oxide, and being of looser, sandstone texture, suffer more loss of mass from the disintegrating effects of the water and atmosphere.

The most north-eastwardly cliff is exposed to the full force of the storms that beat in from Chesapeake bay, and the heavy ice cakes which are driven by the high winds of early spring plunge with terrific force against this side of the rock and dig out cavities near the water line. The most westwardly of these rocks has been cleft into two great pieces by a longitudinal division, and now lies slanting apart at an angle of about forty-five degrees. These pieces are composed in great part of dense siliceous layers, showing no grain, and weather on the upper surface into figures which resemble large fungi and foliated lichens.

Ferric oxide plays an important part in nearly all the members of this mass, but especially in the more granular and less dense portions. The iron solution stains the siliceous grains, eats into their figure, solders the particles into layers, centres around particular spots, enclosing them with a compact shell, and sometimes develops nodular bodies, such as may be observed in many parts of the sandy region east of Baltimore.

Proceeding from this island to the south-west shore of the Patapsco river we fail at first to find the white quartzite, but instead, there are long and wide stratified beds of brownish sandstone, which run back fifty feet or more in one exposure, and penetrate to an unknown distance into the sandy cliff on the northern shore of Stony creek. This is only a disguised form of our white sandstone which has been almost uniformly stained throughout by the ferric oxide. On the opposite shore directly at the mouth of this same creek there is a deposit of the overlying member of this sandstone series, which originally rested at a higher level than the sandstone beds on the opposite shore. By reason of the eroding energies of tide, frost and ice, this upper bed of coarse ferruginous sandstone has been undermined and thrown upon the bottom of what is now the mouth of the creek. This bed which now lies in water six to ten feet deep, is about twelve feet thick, over seventy feet in length, and perhaps sixteen feet in width.

It is a wonderful piece of structure from the curious way in which it has been altered into long hollow pipes, twisted slabs, and serpentine figures, brilliantly charged with the most intense metallic green, blue, red and yellow tints. How far it extends back into the adjoining country has

not been ascertained, but the unbroken end still sticks out of the adjoining cliff, at an elevation of about six feet above the surface of the water. Broken pieces of this rock lie along the shore in this vicinity extending for more than a mile in each direction from this creek.

On going back into the country, at a distance of five miles, the white sandstone again appears in immense deposits from six to twenty-five feet in thickness, and rests upon the sides or summits of such hills as have been eroded enough to cut down to the level of this stratum. The rock underlies the high hills which stretch across the more south-easterly part of this (Anne Arundel) county, and appears at various places over a low plateau or moderately rolling country, where the sand lies exceptionally deep. South-east of this belt high hills of the greensand Cretaceous form an obstructing barrier across the entire width of the county, and render it difficult of access.

In our Albirupean region, however, we rise gradually upon a moderately elevated plateau, which at its highest point midway between the head of the Severn river and Round bay, reaches scarcely more than eighty feet above the level of the tide.

The country sinks down in the direction of the Patapsco river, but rises as we go across the Magothy to the banks of the Severn and beyond towards the Patuxent.

The next large exposure of the white rock appears near the head of the Magothy river, where it is a massive variable quartzite and sandstone, the under-sides and ends of which disintegrate into sand. In many places only the denser and more compact parts remain as boulders or long masses connected with the sand, which still shows the form and stratification of the original rock; but which crumbles into a shapeless pile wherever it is disturbed. Some parts of the sandstone still retains cores of the hard rock, while the other parts extending to a distance of several rods farther on have undergone a sort of restratification and take on a more level bedding.

From the evidences abundantly present in almost every section of this region, it seems perfectly reasonable to infer that the immense body of sand spreading so widely and extending in such deep beds all over the belt, has been derived from the decay of this sandstone, in connection with the brown sandstone which overlies it, wherever the strata have not been too much disturbed.

After crossing the Severn river but few deposits of the white rock come to view. The sand continues on, but the rock lies deep in the ground, so that only in the wells, or in the deep ravines, do we reach the sandstone, and that is usually the upper and ferruginous member of this series.

However, when we reach the vicinity of the fork of the Great Patuxent river, in Prince George's county, the surface of the country is depressed and on a moderately level tract, almost surrounded by an amphitheatre of hills, the dense white quartzite once more makes its appearance. Here we observe a broken sheet of the rock, more than half a mile in length

by three hundred feet in width, and averaging about three feet in thickness, lying almost horizontal in the soil. At present somewhat more than two square acres of it are exposed to view in an almost continuous stratum. It rests here in a marshy meadow, surrounded by a mixed clayey sand, apparently upon the old flood-bed of the Patuxent river. At this point it is composed of bright, mostly compact silex, of great hardness, but with inconspicuous enclosures of kaolinic material, and closely resembles the common type of Potsdam sandstone. More than an acre of its former mass has been carried away to form abutments on the Baltimore and Potomac railroad.

Here it is more substantial than in the vicinity of the Severn, and seems to suffer but little loss from superficial disintegration. Much of its continuation towards the river has suffered from erosive agencies, and lies, in detached pieces, scattered through the woods. But in that part of the area, it is less densely compacted, and presents the appearance of a coarse-grained sandstone.

Beyond this point, in the direction of the Potomac river, no large exposures of the white rock appear, the Cretaceous sands and clays cover the formation, and it is only in a few of the deepest ravines that we meet with the coarse ferruginous sand-rock which belongs to a higher level in the series.

It yet remains to be seen whether this series of rocky strata is continuous with that which skirts the west shore of the Potomac from Mount Vernon southward to Acquia creek. Such examples of the stone as I have compared with the varieties from Maryland are of a different kind of texture. And, although there are various types of structure ranging all the way from a coarse conglomerate to a perfectly homogeneous quartzite, within our territory, those from Virginia are either composed of more crystalline separate grains, or are more decidedly mixed with drifts of coarse kaolinic matter.

On the Severn river we find excellent sections, giving nearly all the members of the series of strata composing the Albirupean formation. Directly on the river, it occupies a tract of country three and a-half miles wide; but it extends in thin deposits, at intervals between the hills on the northwest, back through a distance of at least ten miles more, thus giving it, in the widest part, a breadth of thirteen and a-half miles. The more rocky portions of this belt occupy now, however, a width of about three miles, and are far from being continuously connected, either along or across their line of strike. But they have not been always so restricted, for in nearly every part of the great sand area, decomposing pieces of the stone with the fresh sand derived therefrom may be found after a short examination of the surface.

On the eastern shore of Maryland, in Cecil county, the white sandstone appears on the surface in the form of huge boulders, six to ten or more feet in length, and from two to four feet in thickness. Considerable numbers of these large masses project above the surface at intervals on all the

sandy slopes of the lower grounds near the head of the peninsula bounded on the south by the Elk river. The same rock may also be traced in smaller boulders over the surface of the Cretaceous, the Eocene and Miocene to the vicinity of the Choptank river.

In Talbot county, from three to seven miles inland from Easton, it forms a zone of smaller pieces, as if a barrier of drift-loaded ice had stranded in a line across the country there, and melting had dropped these angular pieces in their present position.

The side of the neck of land adjoining the Elk river has been greatly scooped out by superficial agencies, and apparently a large proportion of the sandstone which originally formed the stratum here has been broken up and transported to a distance.

Some of the larger fragments observed on the surface in Talbot county have broad grooves cut diagonally across their surface, as if they had been pushed along under heavy weights which pressed them against sharp edged stones as they were moved over the surface. One piece in particular, four feet in length, nearly three feet in width and almost two feet thick, deserves to be mentioned here, on account of the singular appearance which it presents. It is a nearly flat slab of the very densest and hardest of the quartzite, very difficult to fracture, and resisting to the edge of well-tempered steel. But, notwithstanding its refractory nature, its upper surface composed of dense quartz is mostly polished, and has a series of three acute-ellipsoid excavations, each nearly three inches in length, more than a half inch in depth, and perhaps two-thirds of an inch in width across the middle. The sides of these holes slope towards the middle line and they are connected in a straight series by narrow grooves.

In addition to those, there are two diagonal channels, each about a twelfth of an inch in width cut along through a space of about six inches.

The piece of stone weighs upwards of six hundred pounds and is not like any that the Indians were accustomed to use in the preparation of their food. It was found lying in a field, at a long distance from any habitation, and does not possess any of the features which might accord with the architectural proclivities of any people thus far recognized.

In summing up we find the Albirupean to be a formation composed, as far as our present knowledge extends, of a lower bed of whitish clayey sand of variable thickness (often of five to twelve feet), followed next above by the white sandstone ranging from five to thirty feet in thickness; or where this is replaced by the pure white sand, being as much as ninety feet in thickness. This in turn is overlaid by thirty feet of black, drab,

red or white clay, which in turn grades into sandy clay and sand, from sixteen to thirty feet in thickness; this is overlaid by five to ten feet of ferruginous sand, carrying more or less pebbly, compact quartz, and this in turn is capped by the ferruginous sandstone ranging from two to twenty feet in thickness, over which, more or less, ferruginous sand, pebbles and gritty material, usually only a few feet thick, extends up to the soil of the surface. Accompanying this upper sandstone small and moderately large boulders of all the varieties of our adjacent Archæan rocks, but particularly of the flaky quartz, similar to that from the mica schists, occur, and sometimes form thick beds in the neighborhood of old river or brook channels.

So, by adding together the various members enumerated above, we reach an aggregate of more than two hundred feet for the full thickness of this formation, as we recognize it at the present time.

It rests below the green sand of the Cretaceous, which on the western shore of Maryland is piled up on a ferruginous sand-crust of its own; but the Albirupean has a much steeper average dip than the Cretaceous, and passes unconformably beneath it, as may be seen in the cliffs of the Severn river near Round bay.

The Albirupean dips eastwardly about ten to twelve degrees, while the dip of the Cretaceous scarcely exceeds five or six degrees.

It is nevertheless a fact that abrupt dips occur in all the alluvial formations of our tide-water region, but these appear to be due to the wavy inequalities of the underlying beds in places where material has been heaped up into hillocks by the arrest of rapid, loaded currents of water.

A similar kind of deposition of loose material takes place at the present time, on the bottom of Chesapeake bay and in the mouths of rivers like the Magothy, where "mud lumps," so-called, accumulate at the points where currents of water meet.

Thus far but few kinds of fossils have been discovered in the Albirupean belt, and these have rarely been found perfect enough for identification. Still, we have one species of Brachiopod, stems of Ecrinites and an Annelid-burrow in the white sandstone, and many unidentified vegetable forms in the dark clays which overlie the sandstone.

Such are a few of the features which characterize the Albirupean formation of the State of Maryland. But our sketch would be incomplete if it omitted to notice some of the peculiarities of the great clay-formation which lies beneath the Albirupean. Both together have been united in a common term as forming what has been called the Jurasso-Cretaceous. But whatever their geological position may be in correlation with the European formations, we are now accumulating information enough to show that they have points of difference from those which have been commonly admitted, and to render it necessary to symbolize them by distinct names. It is with this view that the term Albirupean is here proposed for the great sandrock system lying beneath the greensand Cretaceous, and the term Baltimorean for the conspicuous clay formation which

lies near the bottom of the alluvial column on the Archæan rocks of Maryland.

This Baltimorean formation may be recognized in the prominent hills and ridges of variegated red and white, and lead-colored clays which meet the eye near the roads leading along the inner limits of tide-water, between the head of Chesapeake bay, in Cecil county, and the Potomac river, in Washington.

In turning now to the Baltimorean formation, which is especially well-developed within the limits of that city, we see rather abrupt hills, rising eighty to one hundred feet above the adjacent level, composed chiefly of compact clays, alternating with beds of sand, some of which embrace slender drifts of quartz pebbles and fragments of kaolinic clay.

The formation is made up of numerous strata, constituting altogether a column of alluvial matter more than five hundred feet deep. That part which we can examine at or near the level of the lower streets in south Baltimore exhibits a dark lead-colored compact clay, well-stratified, and resting immediately upon a layer of dense iron clay-stone of only a few inches in thickness. Often the clay which comes in direct contact with this stone is stained a bright red color, is of a very fine texture, and is known as "puddling-clay." On this the distinctly stratified layers of dark clay, ranging usually from seven to nine feet in thickness, are built, and consist of strata varying from three inches to fully two feet in thickness. Between the finely ground layers, in contact with the smoothest surfaces, we meet with the remains of trees, shrubs, vines, ferns, equisetæ, and, perhaps, algæ. These fossil remains occur in the greatest profusion, accompanied by finely reduced lignite in the upper strata. At least five such intervening plant-beds are present in the base of Federal hill and its extension eastwards, in each of which some peculiar form of fern, vine, or leaf serves to distinguish it from the others. It has been my good fortune to discover these beds in this region, and to secure ample collections of all the remains at present found in them, and these are now being figured and described by Prof. Fontaine, of Virginia.

From the lowest layer I have taken out plants only of a low type of structure resembling algæ and nitellas; from the next layer above, equisetæ and ferns with strange vine-like structures; from the layer a few feet higher, buds and twigs of trees allied to the cypress and redwoods of California, as also leaves of ferns having the form of those of the Ginko; from the fourth layer other ferns, coniferous stems, buds and scales, with some leaves of dicotyledons resembling sassafras; and from the upper layer leaves which resemble those of the hawthorn, magnolia, willow, and hemlock. The less distinctly stratified clay overlying these is rich in lignite, often containing the trunks and limbs of nearly entire trees, some of which have been found with spruce-like cones and needle-shaped leaves.

The continuation of this bed upwards is composed of the iron-ore clays which form such conspicuous hills and ridges along the road leading to Washington. In this member of the series lie the extensive layers of

carbonate of iron, the richest of which occur near the base, while the nodules and oxidized lumps are found nearer the surface. The extension of this bed still higher, at various levels, displays the red and white variegated clays, such as we see in large areas in crossing the country south and east of the iron ore hills.

The formation, as far as our present knowledge goes, and disregarding the iron-ore clays, first appears beyond the head of Northeast river on the eastern shore of Maryland, extending thence south of south-west—with an irregular expansion west—down the peninsula between the Northeast and Elk rivers, crossing the Chesapeake bay to Harford county, and proceeding across Baltimore county, the upper half of Anne Arundel and a narrower strip of Howard, Prince George's and Montgomery counties to the Potomac river. It is probably the lowest of the alluvial formations thus far discovered in Maryland resting on the outer, eastward, exposures of the Archæan rocks. Extensive faults in these rocks, besides the erosions, have left deep basins along a wavy line somewhat parallel to the western shores of Chesapeake bay, and in these depressions the beds of the Baltimorean formation have been laid down. At the bottom is found very micaceous sand containing an abundance of that type of compact quartz which belongs to the mica schists, and such as is seen in the Philadelphia micaceous gneiss.*

These micaceous sands form beds in many localities ten feet thick, but oftener much less than that, and they grade almost imperceptibly into obscurely stratified beds of white clay.

Next above this, the white clays alternate with sands in uneven beds, more or less stratified, the sandy members usually carrying drifts of quartz gravel in the lower portion. In some places the clay forms the chief element of these beds, while in others the sands prevail. The entire thickness of this part of the formation ranges from thirty to eighty feet, and is directly overlaid by whitish mixed sandy clay, upon which rests seven to nine feet of a coarse, angular sand, commonly pure white, capped by the thin layer of iron-paint-stone supporting the fossiliferous clay strata and iron-ore beds.

Above these latter the more or less ferruginous sands, mixed with drift of all sizes, form conspicuous beds of very variable thickness. In Clifton reservoir they constitute a series of strata and beds rising thirty feet above the dark or variegated clays, and are overlaid in turn by a few feet of quartz gravel, at or near the surface. Where the clay hills north of Baltimore have been denuded, these gravels are seen at the surface, but where they are undisturbed, the gravel lies from three to ten or more feet below the superficial sand or loam.

The region occupied by this formation is a rolling one, and towards the

* In passing it may be worth while to observe that this variety of gneiss has at one time formed extensive beds in contact with the more basic rocks on the north side of Baltimore, but these have been broken up, and now only their shattered remains rest on, or in, the soil as huge boulders or scattered fragments.

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north, north-east and north-west ascends by a series of sloping terraces, each grading seventy feet or more, to a level of about five hundred feet above tide. This is about the highest limit reached by the variegated clays and gravel which can be shown to belong to this formation. North of the city the Baltimorean extends back through the country to a distance of twelve miles, but it does not rise over the tops of the highest hills, and is often interrupted by the ridges of Archæan and other rocks.

Various changes have occurred to the clays of this formation of which a few examples may be cited.

Where cuttings have been made for streets on the north-east side of Baltimore, and at a point about two miles further east, the iron clays have been dislocated, presumably by floods of water, which have transported and dropped them in large lumps, often two or more feet in thickness. These are mixed in huge piles, and in two places have been thrust over the top of the ferruginous sandstone in such a way as to reverse the order of the series.

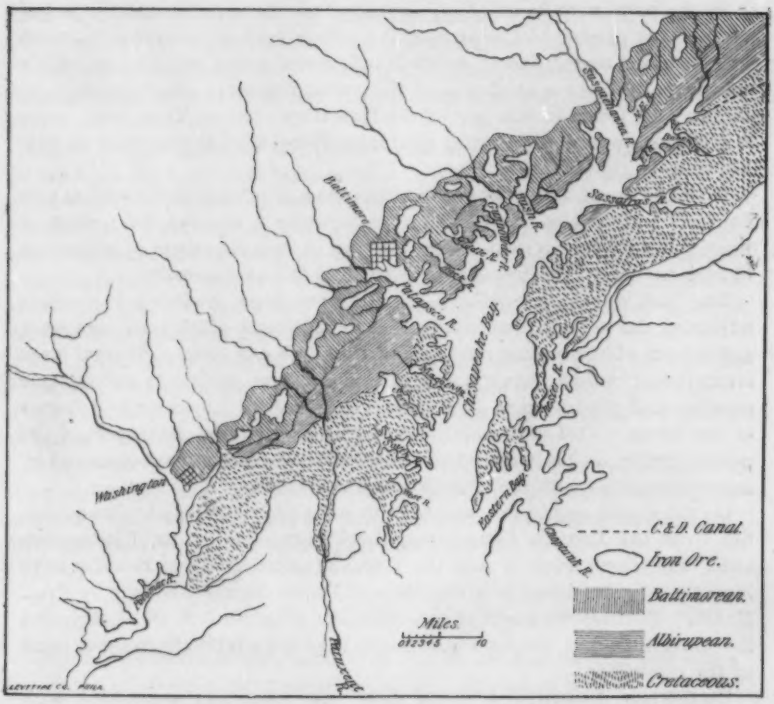
About one mile east of the city, the dark lead-colored clay forms a monumental pile which formerly rose more than eighty feet above the adjoining surface, but it has lost a part of one side by a fault that has produced a downthrow of about seven feet in depth. Another fault, in Federal hill near the end of Warren street, has pushed up the northern end fully seven feet above its proper level. The effects of this dislocation were evident in the broken condition of the beds for about one hundred feet in that direction, while towards the south and south-east there was no break or disturbance in the continuity of the strata.

The red and variegated clays which overlie the iron-bearing member are seen to lie in the hills along the Washington railroad at a much greater elevation than the mixed sandy loam and ferruginous sands which belong above them. This is owing to the fact that in many places the iron-ore series was deeply denuded before the newer beds were laid down ; and in some places there are evidences that the next later deposits have been torn off and transported to a distance.

The iron-ore masters insist that the iron-bearing clays rest in detached domes upon the underlying white sand, but this does not correspond with our observations as far as they have gone. We have traced them in a continuous series nearly all the way from the Gunpowder river to the Relay house, a distance of twenty miles, and again on the other side of Elk ridge to near Annapolis junction.

Beneath the city of Baltimore these clays bend down, but have been penetrated or passed through by all the deep wells of the region, and they are found to possess flexures, one of which carries them beneath the middle and eastern branches of the Patapsco river and brings them up on the opposite shores. In the southern continuation of Federal hill they dip down thirty feet in a distance of four blocks, about 1200 feet; but they are discoverable at the bottom of the deep channel of the river and again form hills a mile beyond on the opposite shore. Nine miles south of

Baltimore these strata dip below the surface of tide, pass under the Albirupean at an angle of about twenty degrees and entirely disappear from view.



Reviewing the three alluvial formations which are passed over between the city of Baltimore and Chesapeake bay, we find that each is overlaid by a system of drift, that of the Baltimorean carrying angular erratics, mixed with compact quartz pebbles, all derived from the Archæan rocks of the neighborhood, with the exception only of boulders of Potsdam sandstone probably dropped by floating ice. In the upper part of this mixed gravel, and commonly above it, rests the stratum of ferruginous conglomerate so conspicuous wherever this member of the series occurs.

It is possible that this is the position in the series to which should be referred the thick beds of gravel and quartz drift that now chiefly lie exposed at or next the tops of some of the low hills north of Baltimore.

Near the summit of the Albirupean, we observe loose strata of gravel and quartz-drift, capped by a crust of ferruginous sandrock composed of unusually coarse grains of quartz. This belt of rock is exceedingly thick in some places, as on the Severn river below Indian landing, where it

reaches a thickness of at least twelve feet. The drift in this stratum is chiefly gravel, with small rounded pieces of the compact quartz, and the pebbles usually enter into the composition of the upper part of the brown sand-rock, making it more or less of a pudding stone.

As the point near Round Bay is approached where this formation passes beneath the greensand Cretaceous, the brown sand-rock divides into two members, the upper one of which is only about a foot in thickness, while the lower one has a thickness of more than five feet. No large angular blocks were found in this part of the formation; but on Valentine's creek it is closely packed with round quartz boulders, such as are made in pot-holes, or in glacial rapids.

Near the top of the greensand Cretaceous a slender drift of small quartz boulders and pebbles occurs, and over this rests a sinuous, flaky crust of finer, powdery ferruginous sandstone, the oblong chambers of which are closely packed with micaceous grayish sand full of glauconite.

The Baltimorean formation seems to have been produced in a region adjoining the sea where accumulations of sand and aluminous mud were ground out of the broken members of the Archæan rocks. Several large rivers brought down their quota of this material, spread it out at their mouths, and piled it up to be farther distributed by the waves and storms of the ocean. Vast accumulations of clay marked the later part of the period during which land-locked bodies of fresh water were connected by narrow channels with the estuaries next the ocean.

On the shores and in the waters of these muddy gulfs and lakes probably lived the Jurassic Dinosaurus, the Pleurocœlus nanus, Pleurocerus altus, Allosaurus medius and the Cœlurus gracilis, whose remains have recently been described from the clays of Prince George's county by Prof. Marsh. To these we may add the Astrodon Johnstonii of Dr. Leidy, and the crocodiles and turtles whose bones have been taken from other parts of the same beds.

On the land flourished a richly varied and abundant vegetation, with forests, fern brakes, and trailing vines, while in the rivulets fresh-water plants spread over the bottom of shallow channels.

Following this came the Albirupean, a more decidedly marine formation, in which sands form the chief element of deposition, and which, later, became a distinctly sandstone-forming epoch. Layers of siliceous plastic mud were spread out over the indurated sands and bound them together in heavy belts of stone. Steady deposition, in wide irregular basins, gradually increased the sedimentary beds and quiet periods allowed the development of aquatic animals. Accordingly in the sandstones of this area we find the burrows of worms, the stems of encrinites, the cells of corals and the shells of brachiopods. On the land an ample vegetation must have existed, since between the layers of an upper bed of clay the densely packed lignitic remains of coniferous trees and the fragments of twigs, buds, leaves and seeds of several kinds of plants are found in abundance. On the south-eastern border of this zone of sand and sand-

stone, the greensand Cretaceous rests piled up in high abrupt hills on the western shore of Chesapeake bay, crossing the country with an unevenly defined breadth of about ten miles. On the Severn river, across the southern part of Round Bay, high domes of these clays and loamy sand form monumental hills, as for example Mount Misery; while between this river and the head of South river almost equally prominent hills arrest the attention of the observer. Crossing the great Patuxent the Cretaceous hills again come into view and finally form high and bold prominences near the Potomac river.

On the eastern shore of the Chesapeake, however, the Cretaceous hills do not form the bold prominences that have been noticed above, but instead, rise into gentler eminences, sloping towards the water courses in moderate rolls, and finding their greatest development along the low ridge which separates the rivers of the Chesapeake from those of the Delaware.

In this formation we have a repetition of the marine conditions of the preceding, but with the added element of the greensand, which now for the first time makes its appearance.

The black loamy beds of this formation are packed with the lignitic remains of trees and plants, while the lower lying greensand, and especially the upper greensand marl beds, are crowded with the casts and shells of many kinds of mollusks.

From what is here recorded it will be perceived that in the State of Maryland there are three well-defined sedimentary formations resting below the Tertiaries, and that the first and last are formed of bold reliefs, while the intervening one is comparatively low and flat.

In reply to the above Professor Carvill Lewis remarked:

That having spent several months in Baltimore and having had some opportunities of studying the geology of that district, in which he had the kind assistance of his friend Professor Uhler, he took the liberty of suggesting certain objections to the conclusions of the foregoing paper and to the adoption of the new term "Albirupean."

A series of three formations, belonging to the "alluvial column," is here described, of which the lowest (the "Baltimorean") is a series of variegated clays and sands, some of which have yielded a fauna and flora indicating a Jurassic or Cretaceous age. These have long been known and are marked on Tyson's Geological Map as the "iron-ore clays" and appear to be the formation already named the "Potomac." Upon these clays Professor Uhler places his so-called "Albirupean," consisting sometimes of sands and clays, sometimes of a massive sandstone or quartzite, containing brachiopods, encrinite stems and annelid burrows; while the uppermost of the "three alluvial formations" consists of Cretaceous greensand. This latter is also well known, having been described by Ducatel in 1834.

As to the "Albirupean formation," the speaker held that Professor

Uhler had here confounded under one name two entirely distinct formations of very widely separated ages. The specimen of "Albirupean" exhibited this evening contains fossils (a brachiopod and encrinite stems) characteristic of a Palæozoic and not a Mesozoic formation, and the petrological character of the rock is also that of an ancient sandstone, resembling the Medina or Potsdam sandstones. The fossils point to the lower Silurian age or thereabouts of the sandstone, and it is probably of nearly related age to the metamorphic limestones which occur in the vicinity of Baltimore. It is of course incredible that a rock of Palæozoic age could overlie the "Baltimorean" clays, and Professor Uhler has given no facts or sections to prove that such is the case.

The mistake has probably arisen in confounding the weathered portions of the sandstone with the sands and clays of Mesozoic or more recent age which occasionally overlie the variegated, iron-bearing clays. As a result of decomposition, the ancient sandstone frequently becomes loose and sandy, and is marked with ferruginous streaks so as to closely resemble the much more recent sands and clays of the neighborhood. An example of this kind may be seen a few miles north of Baltimore. The mistake of confounding the two formations would therefore be a very natural one, especially as the younger formation is in large part made out of the older one, and as outcrops in the region are scarce. Geologists cannot be expected to accept the term "Albirupean;" for even if limited on the one hand to the sandbeds of Mesozoic age, or on the other to the patches of Palæozoic quartzite, it is, to say the least, unnecessary, while if applied to both formations it would be a source of confusion.

Professor Heilprin stated that:

From the data and material presented by Dr. Uhler, he was disposed to agree with Professor Lewis that two or more very distinct formations were included in Uhler's "alluvial column," and that one of these (forming part of the so-called "Albirupean" series) was almost unquestionably Palæozoic. At least, this position was indicated by the brachiopod and crinoid impressions which are seen on some of the rock fragments exhibited before the Society. Neither of these impressions is very distinct, but such relationship as they indicate is more nearly with Palæozoic than with Mesozoic forms. Referring to the formations characterized by Dr. Uhler as "Baltimorean" and "Albirupean," and the "Potomac" of the United States Geologists—the last supposed to be in part synchronous with the preceding—and to the determination of their age as Jurassic, Jurasso-Cretaceous, and Lower Cretaceous (Wealden), Professor Heilprin stated that he failed to find any satisfactory evidence proving the strata characterized to be older than Upper Cretaceous, and that in all probability they are the absolute representatives or equivalents of a portion of the well-known New Jersey series—the colored clays and sands abutting upon the Delaware river.

Epitaph of M. Verrius Flaccus. By Rev. C. W. King, M.A.

(*Read before the American Philosophical Society, December 16, 1887.*)

The collection of antiquities of Count D'Hérisson, the result of long-continued excavations in Apulia and around Carthage, comprised a marble slab, described in the sale catalogue as "The Epitaph of M. Verrio and his brother, Celsus, with two skulls and an axe." But the Count could boast of resembling the "Divine Williams" (as he would call him) in one point at least—that "he had small Latin," for the merest novice in that language could easily read the inscription as: "To Marcus Verrius Flaccus, son of Marcus, of the Tribe Falerina, his brother Celsus [erected this]." I subjoin a *fac-simile* of the epitaph, showing the arrangement and relative proportions of the lettering.

M. VERRIO

M. F. FAL. FLACCO

CELSVS . FRATER.

The inscription is cut in the round, bold character used in the later days of the Republic, and which did not outlast the first century of the Empire. The material is a slab (2 ft. 4 in. by 1 ft. 6 in.) of the marble of Paros, the quarries of Luni (Carrara) were but recently opened when Pliny wrote. The back of the slab has been left very uneven and rough, for the purpose of taking better hold upon the bedding of mortar by which it was inserted in the façade of the tomb, no doubt a brick construction. The once-polished surface is much weathered, giving evidence of the many centuries for which it had retained its original position (and, probably, had witnessed the fall of that Empire with whose birth it was nearly coëval) before it was buried in the earth along with the ruins of the monument. About a third of the surface shows more corrosion than the rest, in consequence of having been covered to this extent by the mortar and the rubbish.

Before attempting to identify the individual thus commemorated, I shall remark that the *Verria* was a plebeian family, and the *Falerina*, in which it was registered, a rustic tribe. "Flaccus" was the actual name of the deceased; for the "Nomen" and "Tribus" of the *Verrius* had been, according to rule, assumed by his father, originally a slave, on becoming a freedman of that family. That "Flaccus" was a word of some *Italic* dialect, perhaps Oscan, in which similar forms occur, as "Maccus," etc., and that, with "Bassus," "Varus," and the like, it denoted some personal peculiarity in the first who bore it, cannot reasonably be doubted, and it may have been synonymous with *pen-*

dulus, in the sense of "lop-eared," * as its derivative *flaccidus* is applied to anything that droops. So far, the marble is of little importance in itself, except as a fine specimen of early Roman epigraphy; but fortunately, this is one of those very uncommon cases, where the name and fame of the deceased are embalmed in history, a circumstance that gives a far higher value to any memorial of the man.

We learn from Suetonius that M. Verrius Flaccus was the son of a freedman (*libertinus*) as was the father of his contemporary and namesake, Horace. He possessed a remarkable talent for teaching; his plan was (apparently an invention of his own) to give his pupils subjects for declamations in which they should compete with each other for the prize, which was a book, valuable either for its *antiquity* or its beauty. The novelty of his system of education appears to have consisted in this. Induced by his high reputation, Augustus appointed him Præceptor to his grandsons, Caius and Lucius; with a salary of one hundred *sestertia* (£1000) a year. He furthermore lodged him with his whole class (of twenty boys) in the palace, making, however, the stipulation that he was not to increase the number of his pupils. Flaccus compiled a Table of Fasti, which was engraved on marble slabs in the *hemicyclium* (alcove) at Prænestе, where his statue was standing when Suetonius wrote. He died at an advanced age, under Tiberius.

Ovid refers (Fast. vi, 58) to this work of our Flaccus, where he makes Juno say:

> "Inspice quos habeat nemoralis Aricia fastos
> Et populus Laurens Lanuviumque nemus:
> Est illis mensis Junonius: inspice Tibur;
> Et Prænestinæ *mœnia sacra* Deæ."

According to this, the Tables of Fasti were built into the walls of the celebrated Temple of Fortune, the special Deity of Prænestе. This explanation has been confirmed by a fortunate discovery. In the year 1770, Foggini, a Roman antiquary, excavated the ancient Forum of Prænestе, and came upon the ruins of a circular [semi-circular?] building, from amongst which he recovered the tablets containing the Kalendar for the months January, March, April, and September, in a perfect state, together with numerous fragments of the others. †

Our Verrius appears to have been held of high authority in matters of antiquity, for Pliny quotes him no fewer than seven times, and always upon curious subjects, as the following will show: "That the Romans upon laying siege to a town, began by evoking the presiding deities of the place (*in quorum Tutela*) by promising them equal or greater honors at

* The *cognomen* "Flaccus" is probably an Oscan word, denoting a personal peculiarity, and signifying "lop-eared."

† Prof. Nettleship, of Oxford, has skillfully reconstructed the plan of Verrius' great work, "De Verborum Significatione," in the American Philological Review, Vol. i, p. 253-70, and ii, p. 1-19.

Rome. A form of evocation was still preserved in the Pontifical Books, and the true name of the guardian of Rome was kept a secret (like the *Shem Hamephorash* of the Jews) for fear some enemy might use it for the same purpose."

"That *Vermilion* was in such estimation with the ancients, that the face of Jupiter Capitolinus was painted therewith on the great festivals; also the faces of generals while they rode in triumph, citing Camillus as an example."

"That Tarquinius Priscus wore a state tunic woven out of gold wire (as was that of Virgil's Lausus)—

Molli mater quam neverat auro.—*Æn.* x, 818.

and like that worn by Agrippina at the opening of the tunnel draining Lake Fucinus."

"That lampreys have *thin*, eels *thick* skins, which were by the ancient laws used for flogging *pueros prætextatos, i. e.*, boys under age, because they were not liable to pecuniary fines; according to the rule that 'he who cannot pay in purse must pay in person.'" Verrius had, furthermore, recorded many instances of *sudden* deaths (which Pliny considers the height of felicity) from joy and similar causes. "That the Romans, for the first three centuries, were not acquainted with *wheat*, but lived upon *spelt* in the shape of porridge (*farre e frumento*)." It is true, that the earliest coins of Metapontum attest that bearded wheat, *triticum*, was the staple in Southern Italy at a period ranging from 700 to 400 B. C.; but the Romans had no intercourse with those parts before the war with Pyrrhus. *Spelt* is the primitive form of the cereal just emerging from the state of a grass-seed; the grains are smooth and very thinly arranged in a long ear. Varro, also, gives the actual date when bakers first came to Rome from Greece, before which time, the inhabitants used the grain only as porridge, *puls*, exactly as the Red Men of our day eat their maize in the shape of *hominy*. Similarly, this simple preparation of grain constituted the national food of the Celts when they had ceased to live entirely upon the flesh and milk of their cattle, for the ill-tempered Jerome, squabbling with the Irishman, Celestinus, despatches him with the sarcasm:

"Hoc non videt Celestinus,
Celtarum *pultibus* prægravatus."

And Ammianus mentions that Julian, in the disastrous retreat from Persia, eat nothing but "parum pultis etiam gregario militi *fastidiendum*," and we must remember that the main strength of the Roman army lay in the Gauls and Germans who had followed the Emperor from the West.

"That the Romans once (the date is not specified) exhibited fighting elephants in the circus; and afterwards, killed them with darts because they knew not what to do with them; not being willing to bear the expense of keeping such huge beasts; or to make presents of them to foreign princes."

These casual extracts sufficiently indicate that had the "Antiquities of Verrius" come down to us, it would have proved as valuable a mine of information for Roman as the "Deipnosophists" of Athenæus is for Grecian archæology.

The *prænomen* borne by Flaccus is not recorded by Suetonius, but Jerome, in his Chronicle, gives it as "Marcus," and puts down the grammarian as flourishing (*floruit*) at the same time with the philosopher Athenodorus of Tarsus. The agreement, therefore, of our inscription with Jerome in this important particular, is strong evidence that both of them are to be referred to the same person, whose date, again, is all but precisely fixed by the archæological proofs deducible from the monument itself.

A "T. Verrius" is one of the Decemviri of Saragossa who coined brass pieces in the name of Augustus in the eleventh year of his reign. Can this man have been the *father* of our grammarian? Certainly the name of his colleague, "C. Alliarius," has so plebeian a sound that we can hardly think it beneath his dignity to have been joined in office with a manumitted slave.

Two skulls, an axe, and an iron bangle, came to London with the monument as having been discovered in the same tomb. These human relics are very remarkable in themselves. The one is that of a man so advanced in life that the *sutures* are entirely obliterated, yet the teeth are sound, though much worn down on one side, as if the owner for some cause had chewed on *that* in preference to the other. The form is unusually elongated, the forehead low but very broad, indicating considerable mental power.

The other skull is the head of a young man, finely-shaped, with teeth of the most exquisite regularity and enamel. As even an Italian *antiquario* could hardly attempt to pass them off (like the celebrated *duplicates* of Cromwell) as those of the *same* man in youth and age, or we may suspect that the mistranslation of the epitaph, as given in the Sale-catalogue, suggested the *discovery* of the remains of the *two* brothers. We must attribute them (if really found in company with the marble) to long subsequent interments in its vicinity. But the question of ownership in the matter of these relics of humanity is, to me, settled by another consideration. It was as impossible for the corpse of Augustus' schoolmaster to have been laid entire in the earth, as it was, but a few years back, for that of an Englishman of the same *status* in his profession, to have been "cremated." That these *crania* should be given to some of the barbarous races, who, long after the times of Verrius, so frequently overran Apulia, may reasonably be conjectured from the articles deposited with them. The *axe*, though greatly corroded, preserves the exact form of the missile *francisca*, the so much dreaded weapon that got its name from the Franks. And the *bangle*, a flat bar one inch in width, meant to be permanently fixed upon the wearer's wrist by the hammering-up of the two ends till they overlap, is an ornament used only by savages. Add to which, the sound condition

of the teeth of the elder defunct at so advanced an age, is a sure proof that he had never enjoyed "the blessings of civilization." (These *crania* are now deposited in the Museum of the College of Surgeons.)

It is so rare to meet with the actual memorials of personages named, ever so incidentally in Roman history, that have escaped "The Goth, the Christian, Time, War, Flood, and Fire," that this marble may justly be reckoned amongst the most interesting relics of antiquity that have come down to our times. As the monument of a great scholar, who enjoyed so high a reputation in the brightest days of literature, no more fitting shrine for its preservation could have been found than the library of Trinity College, where the *Manes* of the ancient Professor will, after so many centuries of oblivion, hear his name and fame once more echoed by thousands of voices—and be (let us hope) propitious to the depositor who has thus carried out the last desire of the tormented ghost:

"Rinfresca la memoria mia che giace."

Obituary Notice of Ferdinand Vandevere Hayden, M.D., Ph.D., LL.D.

By Prof. J. P. Lesley.

(*Read before the American Philosophical Society, January 20, 1888.*)

Dr. Hayden was born in Westfield, Mass., September 7, 1829; was graduated from Oberlin College, Ohio, in 1850; and received a diploma from the Albany Medical College in 1853. Under the orders of Prof. James Hall of Albany, he went with Mr. F. B. Meek to collect Cretaceous and Tertiary fossils in the White River Bad Lands. In 1854–5 he explored the upper Missouri river region, mainly at his own expense, aided by the American Fur Company; following the Missouri river to Fort Benton, and the Yellowstone to the mouth of the Big Horn. His collections of fossils were sent partly to the Academy of Natural Sciences in St. Louis, and partly to the Academy of Natural Sciences in Philadelphia. In 1856 he made a summary report of the whole region which he had explored to Lieutenant Warren, U.S.T.E., and immediately began a general reconnaisance of the North-west as geologist on Warren's staff. This survey extended to 1859. The next three years, to 1862, he explored the Yellowstone and Missouri rivers as naturalist and surgeon to Captain Raynolds' expedition. The Civil War having broken out, Dr. Hayden, in May, 1862, was appointed Acting Assistant Surgeon of Volunteers and placed in charge, first of Satterlee Hospital in Philadelphia, and then (February, 1863, as full Surgeon of Volunteers) of Beaufort, South Carolina. February,

1864, he became chief medical officer of the army in the Shenandoah valley, at Winchester, Va. May, 1865, he was breveted Lieutenant Colonel, and resigned his medical duties for work at the Smithsonian Institution.

In 1865 he was elected Professor of Geology and Mineralogy in the University of Pennsylvania, resigning his chair in 1872 on account of his western explorations; for, in 1866 he explored a second time the Bad Lands of Dakota, collecting largely vertebrate fossils for the Academy of Natural Sciences of Philadelphia. From 1867 to 1879, twelve years, he was United States Geologist in charge of the survey of the Territories. From 1879 to 1883 he was employed as Assistant Geologist of the United States Geological Survey in preparing for publication his surveys in the Territories. Relieved of this literary work in the Spring of 1883, he did field work in Montana until he resigned his position, in the Autumn of 1886, his health having become so impaired that he was confined for the most of the time to his bed. He died December 22, 1887.

Dr. Hayden never practiced medicine, but used his medical knowledge in the superintendence of the army hospitals. He received the title of LL.D. from the University of Rochester in 1876, and again from the University of Pennsylvania in 1886. He was elected a member of the National Academy of Sciences in March, 1856; of the American Philosophical Society in July, 1860; and of many other societies in America and in Europe.

His fame as a geologist in Europe was extraordinary. It is not too much to say that his name was more familiar to the geological world in Europe than that of any other American geologist. This was evident to those of his collaborators in the science who visited the foreign cities, or were in correspondence with foreign geologists. It was due to the exceptional number of his geological contributions, to the freshness of the fields which he explored, and to the untiring energy with which he published his observations as fast as they were made, and communicated them, in large editions, to all the working geologists abroad. The amount of Hayden literature (as it may be justly called) in every library of the world is surprisingly great. More than fifty octavo volumes, copiously illustrated with pictures, sections, topographical and colored maps, were published by him, to make known his territorial surveys from 1867 to 1879. His report on the Warren survey was published by the War Department; and in papers read before the Academy of Natural Sciences of Philadelphia, in 1857 and 1858, and in the Transactions of the American Philosophical Society of Philadelphia, in 1862, describing not only the geology, but the living vertebrates, reptiles, fresh-water fish and shells of the region. Another paper in the Transactions of our Society (of the same date) made contributions to the ethnography and philology of the Indian tribes of the Missouri river. The same year he published a sketch of the Mandan language in the *American Journal of Science;* and in 1869 notes on the Pawnee, Winnebago and Omaha languages in the Transactions of our Society. His second survey of the Bad Lands produced a memoir for the Academy of Natural Sciences of Philadelphia, in 1869.

Dr. Hayden will be remembered as one of the great discoverers of the world in the history of the science of geology. He will be recognized as a man who really opened a new world in the far West to intelligent curiosity and detailed exploration. His influence in educating the western population of the United States was as great as that of Agassiz, in inspiring the population of the eastern States with an enthusiastic admiration for natural history. The two men cannot be compared; for their personalities, their scientific objects, and their methods of research were in strong contrast. Each was an acknowledged leader in his special realm. There was the same indescribable power exercised over a great number of minds. Whatever Agassiz asked for in New England was immediately granted, and with enthusiasm. Whatever Hayden asked for from the people, the politicians, and the Governors of the new States and Territories was allowed to be useful and desirable, and the means placed at his disposal. He represented in science the curiosity, the intelligence, the energy, the practical business talent of the western people. In a few years they came to adopt him as their favorite son of science. He exactly met the wants of the Great West. There was a vehemence and a sort of wildness in his nature as a man which won him success, coöperation, and enthusiastic reputation among all classes, high and low, wherever he went. In the wigwam, in the cabin and in the court-house he was equally at home, and entirely one with the people. He popularized geology on the grandest scale in the new States and Territories. He easily and naturally affiliated with every kind of explorer; acting with such friendliness and manly justice towards those whom he employed as his co-workers that they pursued with hearty zeal the development of his plans.

In dealing with the public men of the country he was so frank, forcible and direct that it was impossible to suppress or resist him. He had the western people at his back so heartily and unanimously that he was for a long time master of the scientific situation at Washington. He was a warm personal friend of some of the highest officials of the Government, who never failed to support strenuously and successfully his surveys. I think that no one who knows the history of geology in the United States can fail to recognize the fact that the present magnificent United States Geological Survey, now under the direction of Major Powell, is the legitimate child of Dr. Hayden's territorial surveys.

Dr. Hayden first conceived the idea of setting aside for national use, as a perpetual park, the region of the Yellowstone geysers. This idea he urged with such success upon Congress, that a law prepared under his direction was passed to that effect. Such a notion would probably have not occurred to the mind of a geologist occupied with the purely scientific details of a new country; and it illustrates excellently well the practical turn of his character.

On the Dicotylinæ of the John Day Miocene of North America.

By E. D. Cope.

(*Read before the American Philosophical Society, February 17, 1888.*)

The number of species of peccary-like pigs whose bones are found in the John Day Miocene beds of Oregon has not been fully determined. Prof. Marsh first determined their existence in this formation, and named a species *Dicotyles hesperius*. He was followed by Leidy, who added *Dicotyles pristinus*. Marsh afterwards described two species under the names of *Thinohyus lentus* and *T. socialis*. The present writer, at a still later date, added three species under the names of *Chænohyus decedens*, *Thinohyus trichænus*, and *Palæochærus subæquans*. My present object is to endeavor to determine the relations of these species to each other and to species and genera of pigs already known.

In the first place none of these species belong to the genus Dicotyles. Their premolars are quite distinct in composition from the true molars as in primitive mammalia generally. In Dicotyles the first in both jaws are identical with the true molars, or nearly so, and the preceding molars have internal tubercles, which the Miocene species do not possess. In Dicotyles there is also a preglenoid crest, which is wanting from the species in question. In all of these points the latter agree with Hyotherium von M. (*Palæochærus* Pomel), of the Miocene of Europe.

The full descriptions given by Gervais, and especially by Filhol, of this genus, enable the fullest comparisons with the American species to be made, at least as regards the cranial and dental characters. From these it results that the latter must be referred to one or more genera distinct from Hyotherium. The principal distinction is seen in the development of the canine teeth in the American forms, and the adaptation of the opposed part of the cranium to the inferior canine. The canines are subtriangular in section, and the inferior tooth is received into a deep fossa of the premaxillary and maxillary bones, as in Dicotyles. In Hyotherium no such fossa exists, and the canine teeth are of relatively small size and of ordinary form. The Oregon species represent one or more genera intermediate in characters between Hyotherium and Dicotyles.

Two generic names have been proposed for these animals—Thinohyus Marsh, 1875, and Chænohyus Cope, 1879. The former is distinguished by Marsh from Dicotyles as follows:* "The most noteworthy differences seen in the remains under description are, an additional premolar in the lower jaw, and the extension of the posterior nares between the last upper molars. The orbit is not enclosed behind, and there is no antorbital fossa. The brain was small, less than one-half the size of that of a Dicotyles of the same bulk—and much convoluted. There is a strong bony tentorial ridge. The molar teeth have the principal cusps more isolated than in Dicotyles and the intermediate lobes larger." It will be observed

* American Journal Sci. Arts, 1875, p. 248.

that this description does not refer to the characters of the premolar teeth which really distinguish these forms from Dicotyles. I also find the tubercles of the molar teeth in numerous examples rather less distinct from each other than is the case in the *Dicotyles torquatus*. Nor do I find the posterior nares to advance between the molars in any of my specimens which are not broken, but, on the contrary, this orifice is generally posterior in position to that which it occupies in Dicotyles. Disregarding these discrepancies, Mr. Wortman and I attempted to redefine this genus,* so as to represent the characters of the species known to us. I am now, however, inclined to think that we were premature in this endeavor, and that it is quite possible that we are yet unfamiliar with the true Thinohyus. As an attempt has been made to define the genus by Marsh, the name will have to be retained, but we must await fuller descriptions both of the genus and of its typical species, before we shall be able to give it its proper place in the system.

My specimens resolve themselves into two series, those which have three premolars in the upper jaw, and those which have four. I do not know of any specimen which has but three premolars in the lower jaw. The fourth premolar (first of the old nomenclature) of the superior series is a small tooth, and may be in some instances subject to irregularities. However, I retain the two genera, and compare them as follows:

Dicotylidæ with premolar teeth all different from true molars.

Inferior canine received into a deep fossa of the upper jaw; canines subtriangular in section; three superior premolars..... *Chænohyus.*

Like the last, but four superior premolars..... *Bothrolabis.*

Canines with oval section, not received into a fossa of the upper jaw; *Hyotherium.*

It may be remarked of the John Day species, that there is no such excess of development of the first superior incisor in them as is seen in Dicotyles, and especially in Hyotherium. Three are constantly present in each premaxillary bone; but each mandibular ramus may have two or three.

In the following descriptions the notation of the premolars used by Kowalevsky and Schlosser has been adopted; viz: p. m. i is the next tooth to m. i.

Lithographic plates of these species have been printed, but cannot be published owing to the change of organization of the U. S. Geological Survey.

CHÆNOHYUS Cope.

Proceeds. Amer. Philos. Society, 1879, p. 373.

CHÆNOHYUS DECEDENS Cope, l. c.

This species was established on a large fragment of the cranium, which includes the orbits and all anterior to it, excepting the dentigerous portion

* Fourteenth Report of the State Geologist of Indiana, 1884, Part II, p. 17. Proceeds. Amer. Philos. Soc., 1887, p. 384.

of the premaxillary bone. It contains the posterior four molars, with the alveolæ of the anterior three premolars and the canine of the left side. The specimen belongs to the collection of Prof. Thomas Condon, of the University of Oregon, who kindly lent it to me.

The skull is remarkable for the abrupt contraction of its outlines anterior to the orbits, both laterally and vertically. The frontal region above and anterior to each orbit is swollen, indicating large sinuses. The anterior orbital border is notched twice, the superior emargination being rather shallow, while the inferior projects in an angle forwards, and the lachrymal foramen enters at its apex, just within the facial border. The muzzle is contracted, compressed, and short. The zygomatic arch springs abruptly, its external surface meeting the everted facial surface in an obtuse vertical angle. This angle is opposite the anterior edge of the second true molar. Its posterior base is opposite the second pair of cusps of the third true molar. The external face of the maxillary bone is directed inwards and backwards from this point, and forms a vertical angle opposite the internal margin of the last molar. Its internal border, commencing at this angle, extends forwards, but I cannot in the specimen distinguish it from the adjacent parts of the palatine bone, on account of its injured state. The palate is flat except next the molars, where its surface is recurved. The frontal region is flat, except at the superciliary borders, where it is slightly decurved.

The nasal bones are narrow, but they expand posteriorly so as to have a width three times as great as at the middle of the length. The posterior outline of both is a single convexity, whose middle point is at the line connecting the anterior border of the orbits. The length of contact of the nasal with the maxillary bones is 12 to 15mm. The lachrymal bone is higher than long, and wider above than below. Its anterior suture is nearly straight. The anterior part of the malar is deeper than the lachrymal, and its anterior suture is concave posteriorly.

The lachrymal foramen is single and round. The infraorbital foramen is vertical and is above the posterior border of the first premolar. The incisive foramina are large. The supraorbital foramina are close together, being separated by an interspace equal one-fourth that which separates each from the superciliary border. The grooves which extend from them anteriorly diverge gradually and are lost near the apices of the premaxillary bones. The palatine foramen is opposite the line of contact between the first and second true molars.

The dental series is remarkable for the rapid diminution of dimensions of the teeth from behind forwards. The last molar is fully equal in size to the corresponding tooth in the *Bothrolabis pristinus*, but the first true molar and first premolar are very much smaller than in that species. The same relation exists between this species and the *B. subæquans*. In comparison with the *B. trichænus*, the anterior teeth are smaller, while the last true molar is larger, in the *C. decedens*. The crowns of the molars are of simple constitution. They consist of four cusps, two external and two internal, the

latter a little benind opposite the former, and connected with them by an obscure intermediate tubercle. The latter is so far fused to the other two as to give a pair of transverse ridges somewhat depressed in the middle. The posterior intermediate on the last superior molar is a little in front of the larger ones which it connects, and a third intermediate is situated behind the space between the latter. This third intermediate is an upward production of a broad cordiform posterior cingulum of the crown. The external cusps on all the true molars in this species are remarkable for having their external faces flat, having thus distinct anterior and posterior edges. The internal face is convex to angular. There is a complete delicate external cingulum, and a wide anterior cingulum, but no internal cingulum. The first premolar has a nearly square outline instead of being transverse, as in the other species, and has one external and one internal cusp, connected by an elevated ridge. No rudiment of external second cusp. The internal cusp is much smaller than the external. A complete cingulum, except on the internal side; the external a delicate one. Second premolar with greater anteroposterior extent than the first. Its base contracts inwards through the obliquity of the external side. The crown is lost. The internal outline of the last four molars is straight, the external a little convex. The second premolar's form adds to the convexity. The alveolar border in front of the second premolar is broken, but there is no trace of alveoli or roots of another premolar until we approach the canine alveolus. Here a single root indicates a rather small fourth (or ? third) premolar. Its long diameter is directed inwards and forwards. The canine is large, but the root only remains in the alveolus. Its outline is that of an isosceles spherical triangle, with the apex directed posteriorly and outwards. Its alveolus occupies an enlargement of the maxillary bone, which is excavated on the anterior face to receive the apex of the inferior canine. This fossa has an acute posterior and superior border. In front its border is excavated by the alveolus of the large third superior incisor.

Measurements.

		M.
Interorbital width		.085
Depth to alveolar border at front of orbit		.080
Length from orbit (between notches) to canine fossa		.091
Width of palate at p. m. i		.0255
" " " m. iii (middle)		.024
Length of molar series		.0815
" " true molars		.044
" " base of p.m. ii		.010
Diameters p.m. i	anteroposterior	.0085
	transverse	.0095
Diameters m. i	anteroposterior	.0115
	transverse	.0125

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Measurements.		M.
Diameters m. iii	anteroposterior	.018
	transverse	.016
Diameters base of canine	anteroposterior	.019
	transverse	.009

As compared with the collared peccary this species has a skull of about the same size, but rather more robust. The posterior molars are considerably more robust.

BOTHROLABIS Cope. Gen. nov.

The species of this genus known to me differ as follows. It may be remarked that they differ from those described by Marsh in their superior size. The latter are represented as being smaller, sometimes much smaller, than the common peccary. Those now described are equal to or larger than that species. The type of the genus is the *B. rostratus* Cope. It very probably includes the *Hyotherium americanum* S. & O.*

I. Muzzle short; a rudimental second external cusp of superior p.m. i.

Superior true molars longer than space from m. i to canine; last superior molar wide as long; fourth inferior premolar one-rooted; infraorbital foramen above middle of p. m. i.....*B. subæquans.*

II. Muzzle medium; one external cusp to superior p. m. i.

Superior true molars as long as space between p. m. i and canine; inferior p. m. iv two-rooted; infraorbital foramen above middle of p. m. ii; last superior molar longer than wide, with three cross-crests and no internal cusp at first valley.....*B. pristinus.*

As in *B. pristinus*, but fourth inferior premolar with one root, and superior m. iii with two rows of tubercles, and an internal tubercle at end of anterior valley..... *B. trichænus.*

III. Muzzle long, compressed; superior p. m. i with one external cusp.

Molars small; true molars shorter than space from m. i to canine, last longer than wide, with two rows of tubercles; infraorbital foramen above middle of p. m. ii.....*B. rostratus.*

These species, with the *Chænohyus decedens*, form a series, which is measured by the increasing length of muzzle, and various other but consequent characters. One of these is the forward movement of the infraorbital foramen, and the anteroposterior development of the fourth inferior premolar. In addition to these, the series displays a coincident posterior extension of the base of the zygomatic arch. In the *C. decedens* it is anterior to the posterior border of the last superior molar. In the *Bothrolabis subæquans* it is opposite the same. In the *B. pristinus* it is posterior, and in *B. rostratus*, very much posterior to the last superior molar.

* Preliminary account of fossil Mammals from the White River formation; Bullet. Mus. Compar. Zoöl., Cambridge, xiii, 5, p. 155, 1885.

BOTHROLABIS SUBÆQUANS Cope.

Palæochærus subæquans Cope. Proceeds. Amer. Philos. Soc. 1879, p. 374.

This species is only known to me from a single nearly entire skull with lower jaw in the collection of Prof. Thomas Condon, of the University of Oregon. The specimen he kindly lent to me, and my description and figures are based upon it. It is distinguished among those of its congeners by its abbreviated and robust form. This is seen in the steepness of its profile, the concavity of the side of the muzzle, and in certain details. Such are the position of the superior p. m. iv within the superior canine; the absence of diastemata between the premolars, and the shortness of the last true superior molar.

The frontal region is swollen above the anterior parts of the orbits, but is concave in front of the temporal ridges, except at the median line, which is obtusely keeled at this point. The profile does not descend abruptly as in the *Chænohyus decedens*, but forms a steeply descending straight line. In the same way the face is not abruptly contracted at the front of the malar bones, but slopes rapidly inwards, giving a wedge-shaped outline from above. Anterior to the compression the facial surface expands laterally and encloses the canine alveoli without abrupt enlargement. Anterior to these teeth the fossæ for the inferior canine are excavated upwards and backwards to a depth of about one-fourth the vertical diameter of the muzzle, the molar teeth being held horizontally. The greater part of the premaxillary bones are broken off. The orbit is not large. The postorbital process is large and decurved, with its compressed-acute apex pointing downwards, behind the line of the postorbital process of the molar. The anterior border of the orbit has two notches, the inferior the larger and including the lachrymal foramen. The supra-orbital border is nearly straight. The temporal ridges are sharply defined. The sagittal crest is compressed and deep through the posterior depression of the brain case, as it does not quite rise to the plane of the facial profile. The occiput is narrow and elevated, and its lateral crests are prominent, enclosing a spoon-shaped occipital fossa. The inion is a narrow truncate angle less than right. The occipital condyle projects at its superior part, exterior to the vertical line of the lateral occipital crest. The crest extends directly towards it without reaching it, and does not turn anteriorly to bound the temporal fossa below as in most Mammalia, including the peccary. It follows that the paroccipital and zygomatic crests originate independently. The latter is prominent, rising abruptly above and sloping backwards and inwards to a prominent apex nearer to the occipital condyle than to the postglenoid process. It has a deep transverse groove on its external face. The posttympanic region is a flat bone spread out against the posterior aspect of the zygoma as in pigs generally. Its flat posterior plane is nearly vertical. Below its inferior border projects the postglenoid process, which is narrow, thinning out and becoming more

prominent externally. At the superior border of the end of the post-tympanic plate the *meatus auditorius externus* issues. The posterior extremity of the angle of the zygoma rises above it, presenting a concave triangular face posteriorly, the apex upwards. The glenoid surface of the zygoma is horizontal in front, but its external half posteriorly rises externally. The otic bulla is larger than in any of the species here described, but its entire boundaries have not been exposed. Its transverse diameter is equal to the space between the apices of the paroccipital and posttympanic ridges. The zygomatic arch is rather short, its external face is flat, and its vertical depth is considerable. Its posterior angle is very prominent and compressed. The occipital condyles are small for the size of the skull.

The mandibular condyle projects very little vertically or posteriorly, but has considerable transverse extent. Its posterior face is in fact vertically truncate and the posterior border of the coronoid process rises directly from the anterior border of its superior aspect. The anterior edge of the coronoid conceals the posterior extremity of the third inferior molar. The inferior edge of the ramus is compressed and straight anteroposteriorly, and a little convex downwards. The symphysis rises obliquely but more steeply than the curvature of the ramus. Its median suture is preserved. The posterior base of the zygomatic arch is in transverse line with the posterior border of the third superior molar tooth. In *Chænohyus decedens* it is anterior to this line, and in *Bothrolabis pristinus* and *B. rostratus* it is much posterior to this line. The masseteric fossa is well marked but shallow in the vertical direction, not descending below the line of the inferior molars.

The nasal bones are narrow medially, but expand at a point opposite the anterior border of the lachrymal bone to four times that width. At the middle line posteriorly they present posteriorly an angle which is about right. The coronal suture crosses the angle formed by the converging temporal ridges, in a nearly straight short line. The apex of the premaxillary does not reach the frontal bone by 35 mm. The latter borders the maxillary by about 10 mm. The lachrymal is about as long as deep, and presents an angular process backwards into the orbit. The malar rises to opposite the lachrymal foramen, and its anterior border does not project beyond that of the lachrymal, and retreats a little posteriorly below. The posterior suture of the malar is not very oblique; it is concave and reaches the base of the postorbital process. The alisphenoid bone has little or no contact with the parietal. The latter descends more than half way to the base of the zygomatic process, and reaches the inion posteriorly. The posterior border of the squamosal is anterior to the lateral occipital crest.

The infraorbital foramen is above the middle of the first superior premolar. The supraorbital foramina are close together, being separated by an interspace which is one-seventh of the interorbital space. The lachrymal foramen is single, large, and within the orbital border. There are

three postparietal foramina, the inferior small and on the squamosal suture. The mastoid foramen is small, is anterior to the lateral occipital crest, and is apparently on a suture. There are two supraglenoid foramina, both small, the larger on the inner side of the base of the zygoma. The *meatus auditorius externus* is small, and is directed upwards and outwards. There is a foramen on the inner aspect of the line of contact of the posttympanic and postglenoid plates, which is probably continuous with the postglenoid. The stylomastoid foramen is, externally at least, longer than the postglenoid. The superior border of the foramen magnum is an open angle.

Of the superior incisor teeth only the third is preserved. The crown is oval and of moderate width. There were two inferior incisors in each ramus. Of the presence of a third I am very doubtful. They have rather narrow truncate crowns of equal width, and are directed upwards at an angle of 45°. The canines are robust. They have a subtriangular section, but the inferior triangle has a truncated (anterior) apex. These teeth differ from those of *B. pristinus* and *B. trichœnus* in having two grooves separated by a ridge on the external sides, instead of one groove. The narrow anterior face of the inferior canine is also shallowly grooved.

The fourth superior premolar is almost entirely within the superior canine. It is small, but two-rooted. The third is much longer, and is much compressed. The second is but little longer than the third. Its crown consists of a single compressed cusp, with an internal cingulum which expands posteriorly, enclosing a narrow basin, and turning outwards forms a narrow basal heel. The first premolar has a base wider than long. Its external tubercle is bifid, the principal one supporting a rudiment of a second. The internal cusp is connected with the external by a transverse ridge, which does not reach the apex of the latter. A wide cingulum forms the internal and posterior outline of the crown. A narrow external, and no internal cingulum. The true molars are subquadrate in form, and increase in size posteriorly. The first is not so reduced in relative proportions as in the *Chœnohyus decedens*. The external cusps are a little flattened externally, not so conspicuously as in the last-named species. Intermediate tubercles are present as in that species. An anterior and a posterior, a faint external and no internal cingula. The posterior cingulum is wide in the second molar and supports a rudimental third intermediate tubercle. In the third true molar it is wider and has a plicate border, but no considerable cusp. The second transverse series of tubercles of this tooth consists of those tubercles besides the intermediate tubercle in front of it, instead of two as exhibited by the other species. The external tubercle of this series is flattened on the external side. The intermediate tubercle of the first row is large and distinct. The crowns of the inferior molar teeth are not visible in this specimen. It can be seen, however, that the only diastemata in the series are very short, and are anterior and posterior to the fourth one-rooted premolar.

Measurements.

	M.
Length from I. iii to inion (axial)	.205
" " " " postorbital apex	.135
" " " " anterior border of orbit	.098
Width of occiput (greatest)	.033
" at zygoma at auditory meatus	.094
" of brain case (greatest)	.043
" at postorbital processes	.088
" " zygoma at front of orbit	.082
" " facial constriction	.048
" " canine alveoli (external)	.062
Least interorbital width	.070
Elevation of inion above foramen magnum	.0545
Vertical diameter of zygoma behind orbit	.022
" " " " at "	.022
" " " orbit	.030
" " " cranium at front of orbit	.070
" " " " at third premolar	.050
" " of mandible at p. m. iv	.025
" " " " " m. i	.039
" " " " " m. iii	.039
Length of superior molar series	.088
" " superior true molars	.048
Diameters superior p. m. i { anteroposterior	.010
Diameters superior p. m. i { transverse	.012
Diameters m. i { anteroposterior	.015
Diameters m. i { transverse	.014
Diameters m. iii { anteroposterior	.0165
Diameters m. iii { transverse	.015
Diameters of superior canine { anteroposterior	.016
Diameters of superior canine { transverse	.010
Diameters crown of inferior canine { anteroposterior	.012
Diameters crown of inferior canine { transverse	.0095
Width of crown of I. i inferior	.006
" " " I. ii	.0055

The skull of this species has just the length and elevation of that of the collared peccary, but is more robust.

BOTHROLABIS PRISTINUS Leidy.

Dicotyles pristinus Leidy, Report U. S. Geol. Survey of the Territories, F. V. Hayden, 1873, I, p. 216; Pl. vii, figs. 13–14. *Palæochœrus pristinus* Leidy, Cope, Bulletin U. S. Geol. Surv. Terrs., 1879, v, p. 58.

Of what I suppose to be this species I have a nearly complete skull without lower jaw, and a lower jaw from which the anterior teeth are

wanting, and a number of tooth-bearing fragments. I found a ramus with symphysis and part of the other ramus of an individual in Prof. Condon's collection, which I refer for the present to this species. The identification rests on the characters of the last two inferior molars, the only parts in the possession of Leidy when he described the species.

The skull is in its proportions intermediate between the extremes in the genus. The profile of the long muzzle is a nearly straight gradually descending line. Viewed from above the muzzle contracts gradually to the compression behind the canine alveoli, and then expands to contract abruptly in front of the latter, to terminate in the parabolic outline of the premaxillary region. The sagittal crest is mostly lost, but it is pretty certain that it descends from the profile line to the inion, which is below the frontal level. The ridge of the muzzle does not expand above the canines. The zygomata are flat. The interorbital region has an undulating surface, owing to the presence of swellings on each side of the middle line, and of a depression at the supraorbital foramina, and an obtuse median keel behind them. The postorbital processes are robust and decurved abruptly, the apices connected with the skull by a transverse plate with horizontal inferior edge. The superciliary border is carried a little anterior to the anterior border of the orbit. This border is only distinct above the lachrymal foramen; below that point the passage from the facial to the orbital surface is uninterrupted. The anterior origin of the zygomatic arch is equally gradual; posteriorly it arises from the posterior edge of the maxillary bone, which forms a line posterior to the third superior molar by 5 mm. Before reaching the longitudinal line of the malar, the border turns backwards and terminates in an apex which is directed backwards and inwards close to the pyramidal process of the palatine bone, from which it is separated by a fissure. The postorbital process of the malar bone is small, compressed and acute. It is anterior to the line of the postorbital process of the frontal. The superior edge of the zygoma is acute; the inferior beveled and truncate. The lachrymal bone extends downwards within the anterior part of the orbit and forms a prominent convexity whose long axis runs downwards and inwards, and it projects behind the posterior boundary of the maxillary bone. It encloses with the superior wall of the latter a deep fossa below and continuous with the orbit. The orbit is bounded posteriorly by a curved ridge which rises behind the foramen rotundum to near the base of the postfrontal process and turns forwards and disappears. A much more prominent angle commences behind the foramen rotundum and rising vertically soon disappears. The temporal ridges are pronounced, and are concave forwards. The lateral occipital crests are prominent and descend to near the condyles. The posterior temporal ridge is weak and continued subhorizontally from the zygoma behind, but it does not reach the lateral occipital crests. The paroccipital process has a robust base which stands at an angle of 45°, being less nearly vertical than in the *B. subæquans*. It approaches nearer to the posttympanic plate than in that species, being

separated by a groove at its apex. The posttympanic is a flat fan-shaped bone appressed close to the postglenoid process. Its inferior edge forms a ridge running horizontally inwards and posteriorly, and enclosing a triangular space with the postglenoid, which is pierced by the postglenoid foramen. Between the foramen and the bulla of the ear is a small pisiform tuberosity. The otic bulla is small, and its long axis is longitudinal; its width is a little greater than the space between it and its fellow, and equals the space between the apex of the postglenoid process and the nearest point of the paroccipital. The basioccipital is weakly keeled at the middle line behind, but it is grooved at the anterior edge through the presence of a tuberosity on each side of the middle line. The groove soon disappears on the sphenoid. The inferior ala of the sphenoid forms with the pyramidal process of the palatine a long wall, which extends from the posterior contact with the maxillary bone to the internal base of the glenoid cavity. Its inferior margin is double, or grooved, the exterior edge being deeper posteriorly, the interior the deeper anteriorly. The posterior nareal border is divided by an osseous septum of 15 mm. in length on the inferior edge; the anterior border of the nares attains the line of the posterior edge of the last superior molars. The palate is flat, except a slight recurvature at the bases of the molars.

The sutural boundaries of the nasal bones are about the same as in the *B. subæquans*. Their anterior extremities are fortunately preserved. They are deeply notched, so as to be bifurcate, the internal angle being about as long as the external. The facial part of the lachrymal is subquadrate and its anterior suture forms a nearly straight line with that of the malar bone. The superior squamosal suture reaches half way to the sagittal crest, but not to the lateral occipital. The maxillopalatine extends anteriorly to a point opposite the middle of the first true molar. The premaxillary extends to within 50 mm. of the frontal, while the latter touches the maxillary by a suture of 10 mm. in length.

The *foramen magnum* is small. The lachrymal is single. The infraorbitale issues above the middle of the p. m. ii. The supraorbitals are close together, being separated by a space equal to one-eighth the interorbital width. The *f. opticum* is rather large and is quite distinct from the *f. rotundum*, though near it. The latter and the *f. sphenoörbitale* appear to be united into a single large orifice. The *f. ovale* and *f. lacerum anterius* are not distinct. There is no *f. lacerum medius*, and the *f. lacerum posterius* is very narrow. The *f. stylohyoideum* is rather large; the *f. postglenoïdeum* looks downwards and inwards from between the posttympanic and postglenoid plates. The *f. condyloideum* is well isolated; it is oval and looks downwards. The *f. magnum* is a wide transverse oval. The *meatus auditorius externus* looks upwards into a triangular groove-like fossa of the triangular posterior face of the zygoma. There is one large postparietal foramen. No supraglenoid foramen. Mastoid foramen small, below the edge of the posttemporal crest. Palatine foramina opposite the middle of the first true molar.

The animal described is mature, and the crowns of the first and second true molars have lost their patterns by attrition. The fourth premolar is small, but is two-rooted, the anterior root nearly reaching the posterior edge of the canine alveolus. The third premolar is like it but larger, the second is still larger, and has the external cusp and internal cingulum spreading posteriorly as in the other species. The first premolar is wider than long and has but one external cusp; it has anterior and posterior, but no external nor internal cingula. The true molars have all the cingula but the internal. The third true molar has three transverse dentinal tracts besides the posterior cingulum, indicating three rows of cusps. The external cusp of the second row is distinct from the others and of conic form; it is bounded externally by the cingulum.

The canine has a single external median groove. Its section is triangular, but the anterior face is not so wide, and the posterior edge not so acute as in the *B. subæquans*. The fossa for the inferior canine enters the premaxillary to a depth equal one-fourth that of the muzzle at that point. In the *B. rostratus* it excavates to a depth of one-half the muzzle. Of the superior incisive alveoli, the first is a little larger than the third, and the third a little larger than the second.

Measurements of skull.

	M.
Length from premaxillary bone to probable inion	.250
" " " " postorbital apex	.175
" " " " preorbital border	.155
" " " " infraorbital foramen	.080
" " " " superior canine	.035
" " " " posterior nares	.148
Length of otic bulla	.0245
Width of otic bulla	.014
" of occiput (greatest)	.040
" at zygoma at auditory meatus	.110
" " " at front of orbit	.100
" of brain case (greatest)	.059
" at postorbital processes	.096
" " facial constriction	.034
" " canine alveoli (external)	.056
" " " " on palate	.034
" between p. m. i.	.024
" " m. iii	.022
" of posterior nares	.0105
" between otic bullæ	.0115
" of foramen magnum	.016
" between orbits (least)	.081
Vertical diameter of zygoma behind orbit	.0225
" " " " at orbit	.0225

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Measurements of skull.	M.
Vertical diameter of orbit	.034
" " " cranium at front of orbit	.078
" " " " " third premolar	.065
Length of superior molar series	.093
" " " true molars	.049
Diameters superior p. m. i { anteroposterior	.0095
{ transverse	.013
Diameters superior m. i { anteroposterior	.013
{ transverse	.015
Diameters m. iii { anteroposterior	.020
{ transverse	.0165
Diameters superior canine { anteroposterior	.015
{ transverse	.009

The skull of this species exceeds that of the collared peccary, and is equal to that of the larger *Dicotyles labiatus*.

The lower jaw belonging to Prof. Thomas Condon, to which reference has been made, is referred with some doubt to this species. This is because it is accompanied by a superior posterior molar, which has not the characters of that of the *B. pristinus* in the lack of the third transverse series of tubercles. It is, however, not certain that this tooth belongs to the animal represented by the lower jaw.

In the latter there are two well-developed incisor teeth and an alveolus for a much smaller external one on each side. The fourth premolar is two-rooted and is separated by diastemata from the canine and from the third premolar of about the same length as itself. The other molars are in an uninterrupted series. The inferior molars have anterior and posterior cingula, but no external or internal ones. On the first and second there are no intermediates; on the third they are represented by median swellings in the bottoms of the transverse valleys. The heel is well developed supporting a median tubercle and lateral crenate edges. A narrow anterior cingulum. These inferior molars have the characters of the specimens described by Leidy as typical of the species.

Measurements.	M.
Width between inferior canines	.013
Diameters of m. ii { anteroposterior	.0175
{ transverse	.013
Diameters of m. iii { anteroposterior	.021
{ transverse	.0125
Depth of ramus at m. ii	.035

BOTHROLABIS TRICHÆNUS Cope.

Thinohyus trichænus Cope. Proceeds. Amer. Philos. Society, 1879, p. 373.

Established on a nearly complete dentition of both jaws in place, but

sufficiently open to display the crowns of the teeth. The rest of the skull is mostly wanting, though some parts of the base are probably preserved in the mass of matrix.

The first incisor is directed nearly vertically downwards. The external face of the crown is an oblique, wide vertical oval, convex on the internal and obliquely truncate on the external edge. The crown of the second incisor is smaller and more acuminate; there is no such difference in size between it and the first, as in *Hyotherium waterhousei* and other species of that genus, and both teeth are smaller than the corresponding ones in the *Dicotyles torquatus*. The superior canine is very robust. Its posterior edge is sharp, and the external face is flat, with a longitudinal shallow groove near the middle. The fourth premolar is wanting from both sides, but a space close behind the canine is probably its alveolus. A short interspace separates it from the third premolar. The latter has two roots and its base is nearly as long as that of the second premolar. The crown is lost. The second premolar is longer than wide, and is wider behind than before. It consists of an external cusp which has an angular apex of moderate elevation, and a basal internal cingulum. The latter arises posterior to the anterior base of the crown as a narrow ridge, and speedily expands posteriorly, enclosing a basin with the external cusp. It does not rise into a tubercle. The first premolar is as wide as long, aud has a subquadrate base. It has but one, a simple external cusp, from the anterior part of which a transverse straight ridge extends inwards and ceases abruptly above the internal base. The posterior base of the tooth is therefore expanded, forming a table, while there is a rudimental anterior cingulum. No internal or external cingula.

The first and second true molars are of subequal dimensions,and are larger than the first premolar. The base of the first is subquadrate and slightly oblique. Its four cusps are connected by wear, so that I cannot determine the presence of intermediate tubercles excepting one near the centre of the crown. A cingulum, except on the inner side; the external faint. In the second true molar two intermediate tubercles are visible, but the anterior is fused with the external and internal anterior tubercles, so as to form a transverse crest, depressed in the middle. The posterior intermediate is in front of the posterior pair of tubercles, and there is no third or posterior cingular tubercle. Cingulum present except on inner side of crown, faint on external side. The third true molar is composed like the second, with the addition of a heel, and a tubercle on the inner side stopping the valley between the two cross-crests. The intermediate tubercles of this tooth are more conspicuous than in the m. ii. and the anterior is of equal elevation with the interior and exterior of the first row. This row is now quite oblique, looking posteriorly inwards. The heel has a median tubercle about the size of the second intermediate, which is flanked on each side by a plicated border or outline. The enamel of all these teeth is smooth.

There are three incisors in each ramus of the lower jaw. Their crowns

are of subequal size, but their edges are differently worn. The first and second are squarely truncate, the third obliquely on each side, so as to give an angular apex. The inferior canine is robust, with the apex directed upwards. The section is subtriangular, with a rather obtuse apex anterior. The external face is flat, and has an open shallow longitudinal groove, which is cut by the face of attrition not far below the apex. Enamel smooth. The fourth premolar is a small tooth with one root entirely behind the canine. It is separated by a very short interspace from the third premolar. It is not clear whether it has one or two roots. The second premolar has a compressed simple crown without cingula. The posterior base is broken off. The first premolar has two subequal closely appressed cusps, anterior to the middle of the crown. In front there is a basal angle; posteriorly a long heel, whose elevated longitudinal ridge is external to the middle line.

The first true molar is wanting. The second displays a crown a little longer than wide. It supports four cusps, without intermediates, whose bases are joined so that wear causes their dentinal centres to become continuous. A swelling in the valley represents the second intermediate cusp, while a similar swelling of the posterior cingulum represents the third. Cingula are represented by a posterior and anterior basal ledge. The third inferior true molar has two pairs of cusps and a large heel, the latter embracing a median basin. A low intermediate tubercle interrupts the middle of the anterior valley, and three low confluent tubercles fill the basin of the heel. The border of the latter is tubercular, the principal one being a little exterior to its median point. No cingula, but a short anterior ledge. Enamel smooth.

Measurements.

	M.
Length of superior molar series	.091
" " true molar series	.0463
Anteroposterior diameter of superior canine	.015
Diameters p. m. ii { anteroposterior	.0115
Diameters p. m. ii { transverse	.009
Diameters p. m. i { anteroposterior	.0105
Diameters p. m. i { transverse	.011
Diameters m. i { anteroposterior	.0132
Diameters m. i { transverse	.0132
Transverse with crown of superior I. i	.010
" " " " inferior I. i	.0055
Anteroposterior diameter of inferior c.	.010
Length of inferior molar series	.099
" " " true molar series	.050
Diameters m. ii { anteroposterior	.015
Diameters m. ii { transverse	.012
Diameters m. iii { anteroposterior	.022
Diameters m. iii { transverse	.012

Further investigations may show this species to be identical with the *B. pristinus* Leidy. The differences at present apparent are: first, the one-rooted p. m. iv, two-rooted in *B. pristinus;* second, the relatively rather smaller molars, especially the third superior. In the *B. pristinus* this tooth has a transverse series of tubercles on the heel which are rudimental in the *B. trichænus*, and the internal tubercle which stops the anterior valley is wanting in the *B. pristinus*. As compared with the *Chænohyus decedens* this species has a longer premolar region, and larger anterior molars and premolars.

BOTHROLABIS ROSTRATUS Cope. Spec. nov.

A cranium nearly entire, but without mandible, represents this species. The specimen indicates a species of larger size than the white-lipped peccary (*B. labiatus*), but of more slender proportions. An important character is found in the small size of the molar teeth. In this respect it compares with the *B. pristinus* much as the black bear compares with the grizzly.

In profile the interorbital region is concave, and the sagittal crest rises above it. The prefrontal region is gently convex, and the top of the muzzle is a gradually descending straight line. Viewed from above the outline is wedge-shaped to the contraction above the third premolar, and then expanded prominently for canine alveoli. The premaxillary region is not longer than in *B. pristinus*, while the facial part of the muzzle is considerably more elongate than in that species. Its profile has no such slope as is seen in *B. subæquans*, nor abrupt descent as in *Chænohyus decedens*. There is no median frontal rib as in *B. pristinus*. The alveolus of the superior canine is produced downwards below the remaining alveolar border, so that the fossa for the inferior canine is excavated into half the depth of the muzzle instead of only one-fourth as in the species already described. This may be a character of the males only. The zygomatic arch is peculiar in that the postorbital portion is considerably shallower than the orbital portion. Its postorbital process is large. The postorbital processes of the frontal are both broken at the apices, but so far as preserved they resemble those of the other species. A little process extends into the orbit from its anterior border, below which the latter is not very well defined. The orbit is not very large, and its long axis is oblique anteroposteriorly and in the vertical plane. The posterior apex of the zygomatic process of the squamosal is broken, but it was evidently not so robust as in the species already described. The postglenoid is transverse and compressed to an acute free edge, and the posttympanic plate is closely appressed to it. The paroccipital process is elongate, and the apex contracts from the base. The latter lies at an angle of 45° inwards and forwards, rising from the edge of the otic bulla. The occipital condyles are small, and are laterally expanded. The otic bullæ are placed longitudinally and are small regular ovals. Their transverse diameter is less than the width of the space between them, and equals the space between the external bases of the postglenoid and paroccipital processes. The basi-

occipital is flat posteriorly, but anteriorly it has an open shallow median groove, with a low ridge on each side.

The occiput is damaged, but the lateral occipital crests descend to near the condyles without sending a branch to the zygoma. The posterior temporal ridge commences above the external portion of the occipital condyle. A single prominent angular ridge dividing the temporal from the orbital fossæ continues from the postfrontal process to internal angle of the preglenoid boundary. The inferior sphenoid ala is continuous from this point to and with the pyramidal process of the palatine, forming a vertical plate flared outward at its superior border. The border of the posterior nares is about as far posterior to the last superior molar as the length of that tooth, and opposite to the posterior extremity of the maxillary bone. This is further posterior than in any of the other species. The zygomatic foramen is encroached on by the convexity of the inferior part of the lachrymal bone which is in this species subhorizontal, and not oblique as in the *B. pristinus*. It is therefore continuous with the zygomatic expansion of the maxillary bone, and serves to place the posterior origin of the zygomatic arch much further back than in any of the other species here described. The outlines of the zygomatic arches are flat, and slightly wider behind than before. The palate is flat, except posterior to opposite the last superior molars. It then slopes upwards at an open angle. The premaxillary palatal face is a little decurved.

As the animal described is old, the sutures are obliterated.

The infraorbital foramen is above the middle of the second superior premolar, and is a vertical oval. The supraorbital foramina are small and close together, the space between them being one-seventh the interorbital width. There are two postpariëtal foramina placed rather low down, the inferior on the squamosal suture. A very small supraglenoid foramen on the inner side of the zygomatic process. The *foramen magnum* is wider than deep if we except a deep notch of the superior border. The *f. condyloïdeum* is entirely distinct, and is a longitudinal oval. The *f. ovale* is not distinct from the *f. lacerum anterius*. The *f. postglenoïdeum* is at the inner side of the postglenoid process. The meatus auditorius externus is lost with the zygomatic angle, but its canal is remarkably small. The *f. palatinum* is opposite the first true molor. The *ff. incisiva* are distinct from each other, and rather large, the two, with their septum, forming a circle.

The incisive alveoli of the premaxillary are of moderate size, and the first and third are equal, and the second a little smaller. The canine alveoli are large and pedunculate; the crowns are lost. The fourth premolar is separated from the latter by a diastema; it has a simple compressed crown, and is two-rooted. The third premolar is similar but larger, and is preceded and followed by diastemata, the former as long as itself, the latter a little shorter. The second premolar is like that of the other species of the genus. The first is wider than long, and has one external and one internal cusp, and posterior and anterior cingula, the former the wider. The crowns of the first two true molars have lost their

pattern through wear. That of the third is but little larger than that of the second. Its posterior border is obliquely convex, being most prominent at the internal side. It has two cross-rows of cusps and a heel, the latter with an internal cusplet. The intermediate tubercles are distinct, and there is one in the valley between the two rows. This tooth has only a trace of an external cingulum, and no internal one.

Measurements.	M.
Length from premaxillary bone to foramen magnum inclusive	.270
" " " " postorbital process	.228
" " " " preorbital border	.185
" " " " infraorbital foramen	.105
" " " " superior canine	.040
" " " " posterior nares	.173
" of otic bulla	.0215
Width " "	.016
" at zygoma at auditory meatus	.098
" " " " front of orbit	.118
" of brain case (greatest)	.026
" at postorbital processes	.083
" between orbits (least)	.078
" at facial constriction	.041
" " canine alveoli (external)	.059
" " " " on palate	.036
" between p. m. i	.029
" " m. iii	.033
" of posterior nares	.011
" between otic bullæ	.016
" of foramen magnum	.018
Vertical diameter of cranium at last molar	.079
" " " " third premolar	.043
" " " orbit	.035
" " " zygoma at orbit	.024
" " " " behind orbit	.016
Length of superior dental series	.152
" " " molar "	.089
" " " true molars	.044
Diameters of p. m. i { anteroposterior	.010
Diameters of p. m. i { transverse	.013
Diameters of m. i { anteroposterior	.013
Diameters of m. i { transverse	.014
Diameters of m. iii { anteroposterior	.018
Diameters of m. iii { transverse	.0125
Diameters canine alveolus { anteroposterior	.016
Diameters canine alveolus { transverse	.0135

From the John Day bed of Oregon, on Camp Creek. Discovered by Dr. J. L. Wortman.

On the Mechanical Origin of the Dentition of the Amblypoda.

By E. D. Cope.

(*Read before the American Philosophical Society, February 17th, 1888.*)

As the Amblypoda form the only order of ungulate Mammalia with tritubercular superior and tuberculo-sectorial inferior molars, the question has arisen in my mind why they did not develop a sectorial dentition in the same way, and for the same mechanical reasons, that the unguiculate series has done so. Having recently assigned* certain mechanical reasons for the evolution of the sectorial teeth of the Carnivora, it is necessary to explain why the Amblypoda, which had apparently the same mechanical conditions at the start, did not eventually produce the same result.

In the first place I observe in the families Coryphodontidæ and Uintatheriidæ of the Amblypoda, that the shearing the inferior molar crests against the superior molar crests, is from before backwards. In the Creodonta and Carnivora it is from behind forwards. I supposed the latter movement to be due in these animals to the wedging of the inferior canine in front of the superior canine, a movement undoubtedly sufficient to account for such a shearing, other things being equal. But in the Coryphodontidæ the canines are greatly developed, yet the shearing of the molar crests is in the opposite direction. It is also evident that the development of the canines cannot have been the cause of the maintenance of any kind of a shear between alternating parts of molar teeth, otherwise the quadritubercular type of molar would not have come into existence in such families as have large canine teeth, such as the Suoïd Artiodactyla. I do not for these reasons abandon the opinion that the development of the canines has not had a great deal to do with the development of the sectorial dentition. I only deny that it has been the cause of its *origin*, that is, of the anterior shearing of the lower molars on the upper, at its beginning.

The divergence of mammalian dentition into the two types, the tritubercular and quadritubercular, has been, as it appears to me, due to the adoption of different food-habits. The tritubercular is the primitive, and is adapted for softer food, as flesh, so that primitive placental Mammalia were carnivorous or nearly so. The mastication of hard food was impossible until the molars of the two series opposed each other, and this was not accomplished until the quadritubercular superior molar was produced. This was accomplished, as I have pointed out, by the addition of a posterior internal tubercle, and I suspect that the mechanical cause of its origin was the attempt of the animal in mastication to crush substances harder than flesh against this posterior edge of the superior molar, by applying to it the anterior edge of the lower molar. In the devouring of flesh this movement is not necessary or only necessary so far as to produce a shear-

* The Mechanical Origin of the Sectorial Teeth of the Carnivora. Proceeds. Amer. Assoc. Adv. Sci. 1887, p. 254.

ing movement to cut a resisting ligament or tendon. The different mechanical movements in the two cases were due to the manipulation of its lower jaw by the animals, just as we may see them to-day endeavoring to masticate substances in accordance with their hardness, form, etc. It would appear in the case of the tritubercular superior molar, that the impact during the effort to masticate hard and tough substances, as vegetable tissues, and seeds, has had its usual effect to stimulate deposit of material. The shearing movement has had an opposite effect, viz., that of wearing away the surface subjected to it, and the flattening of the sheared face. That the development of the grinding mastication should take place in ungulate Mammalia is entirely appropriate to the structure of their digits; the hoofed structure unfitting them for the seizure of living prey.

In the Amblypoda, however, we have a hoofed order in which the primitive tritubercular superior and tuberculo-sectorial inferior molar remained. Of the three families, the latest, the Uintatheriidæ, display the greatest anomaly, while the earliest, the Pantolambdidæ (of the Puerco) give the simplest known type. It is to the intermediate family, the Coryphodontidæ of intermediate age (the Wasatch Eocene) that we must first look for the explanation of the peculiar characters of the order.

Before doing so I give an explanation of the various mechanical types of mastication:

I. Part or all of inferior molars work between superior molars. Amœbodect mastication.

1. The inferior molar shears forwards on the superior molar. Proterotome mastication; Creodonta, Carnivora.
2. The inferior molars shear posteriorly against the superior molars. Opisthotome mastication; Coryphodontidæ, Uintatheriidæ.

II. Molar teeth of both jaws oppose each other. Antiodect mastication.

3. The movement of the lower jaw is vertical. Orthal mastication; Suoïdea, Tapiridæ.
4. The movement of the lower jaw is from without inwards. Ectal mastication; many Perissodactyla.
5. The movement of the lower jaw is from within outwards. Ental mastication; most Artiodactyla; some Perissodactyla.
6. The movement of the lower jaw is from before backwards. Proal; most Rodentia.
7. The movement of the lower jaw is from behind forwards. Palinal; Proboscidia (Ryder).

The methods of mastication of Division I may be also defined by the terms of Div. II. Thus the proterotomes are all orthal, and I will show that the opisthotomes are also ectal. Some of the orthals are opisthotome, as the Tapiridæ.

The peculiarities of the Pantodont and Dinoceratous dentition may be now taken up in order, and their mechanical causes assigned so far as possible. *In limine* I take the position that the mastication of the Amblypoda was accomplished by the transverse movement of the lower jaw

across the upper, and that this is, therefore, the only order in which such mastication was performed by the primitive dentition, *i. e.*, the tritubercular and tuberculo-sectorial. That this is the type of mastication is suggested, but not proven, by the anisognathism of the dental system. But it is proven by the mark or path made by the posterior external cusp of the inferior true molar across the crown of the superior molar in the Coryphodontidæ. This cusp struck the posterior side of the rudimental anterior external lobe, and passed transversely across the crown (diagonally to the principal cross-crests), and slid up the apex of the internal cusp, producing the externally directed angle in its wear, seen in all specimens of the genera Metalophodon, Coryphodon and Ectacodon (Fig. 3). I also suspect that this movement is ectal, since the directions of the V's of the two dental series will permit no other. An at-

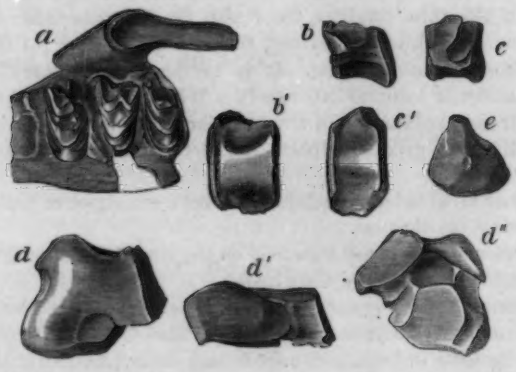

FIG. 1.—Bones and teeth of *Pantolambda bathmodon* Cope, two-thirds nat. size. From the Puerco beds of New Mexico. Fig. *a*, part of maxillary and malar bones from below, showing true molars, all somewhat broken. Figs. *b* and *c*, cervical vertebræ, left side; *b'* and *c'*, do. from below. Fig. *d*, astragalus from above; *d'*, from front, showing facet for cuboid; *d''*, from below; *e*, navicular bone from below. Original, from Report U. S. Geol. Surv. Terrs., F. V. Hayden.

tempt at an entel movement results in a jamming of the V's into each other, and further progress is impossible. It may be objected that the presence of the large superior canines forbids any considerable lateral movement of the lower jaw. The superior canines are however so divergent in the Coryphodontidæ that such movement is possible, and the transversely convex wear of these teeth proves just such a movement of the inferior canines on them. The lateral movement in the old males of the Dinocerata has been much restricted, but in younger males and females it was possible.

A second proposition is demonstrated by the discovery of the Pantolambdidæ. This is, that the superior molars of both the Coryphodontidæ and Uintatheriidæ are derived from a type with two external V's (Pantolambda, Fig. 1), and I propose to show how this derivation has been

accomplished, and under what mechanical necessity. Pantolambda also

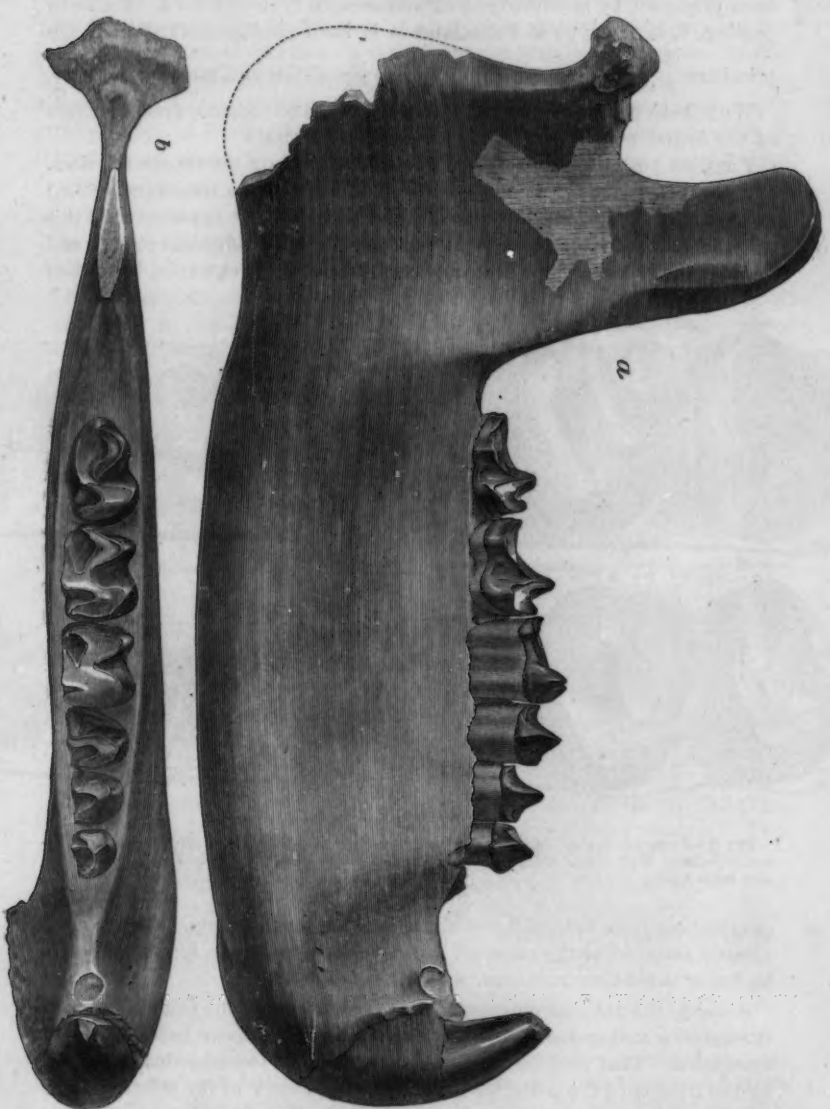

FIG. 2.—*Pantolambda cavirictus* Cope, mandibular rami, two-thirds natural size. Fig. *a*, right ramus for outer side. Fig. *b*, left ramus from above. From the Puerco bed. Original, from Vol. iii, Report U. S. Geol. Survey Terrs., F. V. Hayden in charge.

shows that the inferior molar structure of the two types mentioned has been produced by modifications of a W-shaped type of crown. I note in passing, that the type of Pantolambda is itself readily derived from the primitive $\frac{3\text{-tubercular}}{5\text{-tubercular}}$ type of primitive placentals and marsupials.

With these propositions established, I proceed to consider first the origin of the dental peculiarities of the CORYPHODONTIDÆ.

First, no posterior inner tubercle was developed on the superior molars. We may regard this as a consequence of the fact that a transverse (ectal) movement of the lower jaw was established before the appearance of this cusp, instead of after it, as was the case in other ungulate orders, and because the shearing has been always from before backwards, instead of

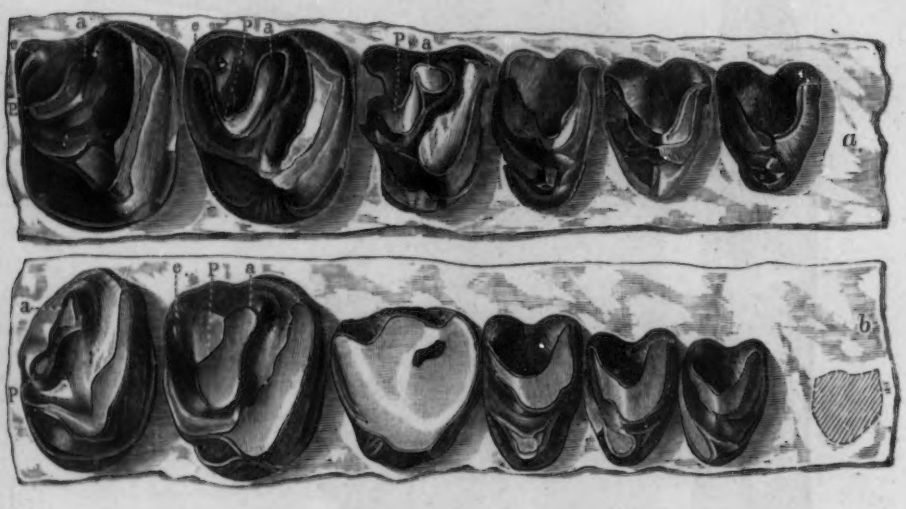

FIG. 3.—Superior molar series of Coryphodontidæ, two-thirds nat. size, from the Wasatch beds of Wyoming. Original. Fig. *a*, *Ectacodon cinctus* Cope. Fig. *b*, *Metalophodon testis* Cope.

overlapping from behind forwards, as in all other Ungulata. The stimulus already assigned as the cause of the development of the fourth tubercle is, under these circumstances, wanting. (Fig. 3.)

Second, the anterior cingulum, which extends from the internal cusp to the anterior external angle of the crown along its anterior base, is greatly developed. This may be reasonably ascribed to the stimulus produced by the friction of the posterior limb of the anterior V of the inferior molar in the transverse movement in mastication. The anterior crest of the superior molar is developed instead of the corresponding posterior crest of the superior molar in front of it, because the transverse movement of the

inferior molar follows a path much more nearly coinciding with the anterior crest of the superior molar than with the posterior crest. That is, it follows a curved path of which the centre is posterior, and near or between the glenoid cavities on which the mandibular rami move, as has been described by Ryder in various other ungulates.* This is the probable cause of the development of this crest from its originally moderate proportions in Pantolambda (Fig. 1), and from the unknown ancestor of that genus, where its dimensions are presumably still less considerable.

Third, the anterior external tubercle or V is reduced to a conical rudiment (Fig. 3 *a*). This is evidently due to the disuse following the great development of the anterior cingulum which extends from the internal tubercle to the anterior external angle of the crown. A similar but less considerable development of this ridge is accompanied by a corresponding reduction of the anterior external lobe, in some genera of the Lophiodontid Perissodactyla. The reason why this V has been extinguished and not merely pressed backwards, is the fact that the posterior external V of the superior molar has retained its place, and has not given way to allow room for the anterior one. This V has retained its place partly on account of its remoteness from the source of pressure in front, but principally because it fits the posterior transverse crest of the lower molar in front, and the anterior oblique crest of the next succeeding lower molar behind, so that its use has been only possible in its primitive position.

Fourth, the posterior limb of the posterior external V of the superior molar is wanting on the last molar in Coryphodon, and from the last two in Metalophodon (Fig. 3). The absence of this crest from the last superior molar is due to the absence of a corresponding crest of the inferior molar (Fig. 4). This is the oblique crest at the anterior extremity of the inferior molar, and it shears against the posterior limb of the posterior external V of the superior molar, representing the sectorial blade of Carnivora. It is little elevated in the Coryphodontidæ, owing to the fact that it is little used, since the crests of the inferior molars shear backwards and not forwards on those of the upper. The effect of this disuse tends, in the history of the Coryphodontidæ, to become more and more evident. The non-existence of a fourth molar behind the third in the lower jaw, accounts for the absence of the crest in question from the last superior molar, while the absence of the same crest from the second superior molar of Metalophodon, indicates the absence or rudimentary condition of the corresponding crest of the corresponding inferior molar.†

* Proceedings Philadelphia Academy, 1878, p. 56.

† I have just detected an error in Plate xlvi, Tertiary Vertebrata, which has been copied in *American Naturalist*, 1884, p. 1198, by which the artist has drawn the left ramus mandibuli of *Bathmodon radians* in the place of the right one. The two rami are in the specimen separate from the symphysis, and the artist has simply drawn the ramus in connection with the wrong branch of the symphysis. I had not noticed this egregious blunder until the present writing, and no one else appears to have observed it.

The above four propositions cover the principal peculiarities of the dentition of the Coryphodontidæ. I now proceed to a consideration of those of the UINTATHERIIDÆ.

FIG. 4.—*Coryphodon latidens* Cope, lower jaw, one-third natural size, from the Wasatch epoch of New Mexico. Fig. *a*, right ramus from internal side. Fig. *b*, both rami from above. Original, from Report U. S. G. G. Surveys W. of 100th Mer., G. M. Wheeler in charge. This specimen has an anomalous premolar.

As is well known, the crowns of the superior molars in this family support two cross-crests, which converge and nearly join at the internal extrem-

ity of the crown (Fig. 5). The anterior of these crests is pretty clearly the anterior cingular crest of Coryphodon, but the homology of the posterior crest is less obvious. In order to determine this point recourse must be had to the inferior molars, which are more readily understood.

FIG. 5.—Dinocerata teeth, one-fourth nat. size. Upper figures superior molars of *Uintatherium leidianum*, one-fourth nat. size. Lower figure, inferior molars of jaw of another species of Uintatherium. From Osborn, memoir on Uintatherium and Loxolophodon.

In the lower molar of the Uintatheriidæ, we find the anterior triangle of the tuberculo-sectorial type, but with the anterior limb rudimental. The posterior part of the crown differs from that of the Coryphodontidæ in having no posterior transverse crest, but in its stead the diagonal crest which connects the external extremity of the posterior transverse with the interior extremity of the anterior transverse crest. This oblique crest wears the posterior crest of the superior molars on its anterior face, as the anterior transverse crest wears the anterior crest (cingular) of the superior molar on its anterior face. (Fig. 6).

Comparison with the dental structure of Pantolambda (Fig. 1-2), shows which crests of the two series stand in this relation to each other. The diagonal crest of the inferior molar in this genus shears in front of the posterior limb of the anterior V of the superior molar. Guided by this fact we may regard the posterior cross-crest of the superior molar of the Uintatheriidæ, as the posterior limb of the anterior external V. We must then suppose that the anterior limb of this V has disappeared from this type of molar, and the anterior cingular crest has taken its place, thus forming a long V with the posterior limb. The tubercle between the crests at their open external valley, may be a remnant of this external crest. A low tubercle on the crown behind the inner extremity of the posterior crest, may be a rudimental fourth tubercle, or even the apex of the posterior external V.

The homology of the posterior crest of the superior molar here proposed is sustained by the fact that there is no posterior transverse crest on the lower molar.* Had the crest in question been part of the posterior V of the superior molar, the posterior crest of the inferior molar would have had use, and would not have disappeared.

If this homology is correct, the Dinocerata were derived directly from the Pantolambdidæ, and not through the Coryphodontidæ.

* The raised heel on these inferior molars is not the posterior transverse crest.

The mechanical causes of the peculiarities of the Dinoceratous dentitions are then the following :—

First, development of anterior cingular crest; cause same as in Coryphodontidæ.

Second, loss of anterior limb of anterior external V of superior molars; cause, disuse.

Third, shearing of oblique crest of inferior molar in front of instead of behind posterior limb of anterior external V of superior molar. Cause, development of anterior basal cingulum of superior molar, which wedges cross-crests of inferior molar anteriorly.

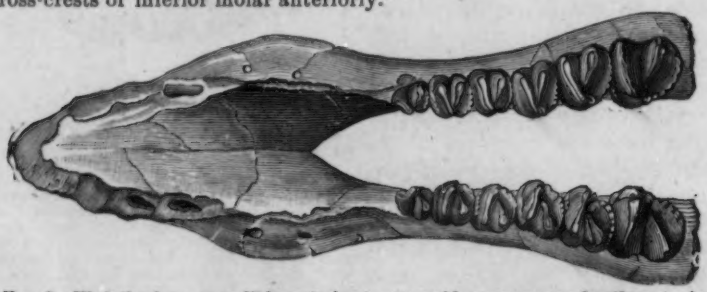

Fig. 6.—Uintatherium, mandible anterior to coronoid process, one-fourth nat. size; from Bridger beds of Wyoming. From Osborn, memoir on Loxolophodon and Uintatherium.

Fourth, loss of posterior cross-crests of inferior molars. The answer to this question is the answer to the other question, Why was the oblique crest of the inferior molar developed in the Uintatheriidæ while it remained rudimental in the Coryphodontidæ? The answer to these questions is the explanation of the principal peculiarities of the former family. The answer appears to me to be simply that while the movement of the lower jaw in mastication was probably ectal in the Coryphodontidæ, it was probably ental in Uintatheriidæ. This explanation is largely hypothetical, yet it accords with the relations between use and the development of the crests in the two families. In the ectal movement in Pantolambda the oblique crests of the opposing molars are soon separated from mutual contact, so that none of them have use on the internal half of the crown except the anterior cingular. In the ental movement, on the other hand, the limbs of the external V's are used to the utmost. The posterior limb of the anterior V is most used in Pantolambda, for the reason, as it appears to me, that the inferior molar is wedged forwards as it moves outwards in consequence of the guidance of the anterior cingular crest, and the wedge-shape of the triangular superior molar. While this causes the greatest use of the posterior limb of the anterior external V, it withdraws the posterior crest of the inferior molar from shear with the anterior crest of the posterior V, so that it has disappeared through disuse.

In general it may be observed, that the ental movement is the easier to the Dinocerata because the V's open exteriorly in both jaws. In the Pantodonta the ectal movement is easier, because the V's of the lower molars open interiorly.

The Glosso-pharyngeal Nerve in the Domestic Cat.

By T. B. Stowell, A.M., Ph.D.

(*Read before the American Philosophical Society, March 2, 1888.*)

Introduction.—The following study in comparative neurology is a continuation of the contributions made by the author and already published in the Proceedings of the Society. [The Vagus Nerve in the Domestic Cat (Felis domestica), read July 15, 1881; The Trigeminus Nerve in the Domestic Cat, read May 21, 1886; The Facial Nerve in the Domestic Cat, read Nov. 5, 1886.] The object of these contributions has been presented in the previous papers.

I am not aware that any one has published the detailed distribution and relations of this nerve; this study is therefore offered as a contribution to comparative neurology.

Preparation.—As previously recommended, the cats were injected with the "starch injection mass." The dissections have been verified upon alcoholic and upon recent specimens; the nerves have been traced under a magnifying power of 15–25 diameters. It is hoped that such a degree of accuracy has been attained as will render this study serviceable to students of the nervous system.

Description.

Synonymy.—Nervus glosso-pharyngeus, N. pharyngo-glossus, Glosso-pharyngeal nerve, Eighth pair of cranial nerves (Willis), Ninth pair (Sommering).

General Characters.—The N. glosso-pharyngeus is the cephalic member of a group of nerves whose ectal origin is along a line caudad of the eminentia auditoria and dorsad of the area elliptica. The common niduses in man from which the ental fibres of these nerves arise have been designated the "nuclei of the lateral mixed system" (28, p. 747).

The N. glosso-pharyngeus is characterized by the presence of two ganglia upon the central portion of the nerve-trunk, the central one (Fig. Ehr.) is within the foramen of exit (Fm. jugulare), the peripheral one (Fig. Pe.) is about 7 mm. peripherad of the foramen. The presence of the root ganglion and the ental origin ally this nerve and the dorsal roots of the myelic nerves.

The glosso-pharyngeus is specifically the sensory nerve of the pharynx, of the mucosa of the tympanum, and of the basal (circumvallate?) papillæ of the tongue. It includes motor fibres which are given to the cephalic pharyngeal constrictor and to the stylo-pharyngeus muscles. Communicating rami connect the N. glosso-pharyngeus with the N. vagus, the N. sympathicus, the G. oticum, and with the N. facialis.

The glosso-pharyngeus is peculiarly the nerve of deglutition as well as the nerve of taste. The importance of having these functions associated

in the same nerve appears when the relation of food-stuffs to life is considered. The inverted muscular reaction which ensues upon the application of an unnatural or irritating stimulus is another characteristic of this nerve.

The conflicting evidence of Bell, Longet, Panizza, Reid, Mayo, Bernard, Chauveau, and other experimenters, leaves grave doubt as to the susceptibility of the N. glosso pharyngeus to receive painful impressions.

I am not aware that the function of the tonsillar branch has been demonstrated.

Ectal Origin.—The ental roots (5–6 funiculi) constitute a small nerve-trunk whose ectal origin is in the depression line dorsad of the oliva, the line of origin of the dorsal roots of the N. vagus [indeed, the cephalic funicle of the vagus seems to belong to the root funiculi of the glosso-pharyngeus]. The trunk so formed lies ventrad of the plexus choroideus lateralis and passes laterad to the foramen of exit.

Foramen of Exit.—The nerve takes its exit from the cranium through the foramen jugulare in connection with the vagus and the accessorius nerves, the jugular vein, and a small arteriole from the A. occipitalis.

Intercranial Course and Root Ganglion.—In the passage through the jugular fossa the sheath of the N. glosso-pharyngeus is distinct from and cephalad of the common sheath of the vagus and the accessorius and is separated by the arteriole above referred to. At the central end of the fossa the N. pharyngeus bears a small pinkish ganglion (G. ehrenritteri, G. nervi glosso-pharyngei superius, G. jugulare superius, G. mulleri). This ganglion lies upon the ectal surface and the ventral border of the G. jugulare of the N. vagus, but it does not appear to have structural relations with the ganglion. The ganglion (G. Ehr.) is ectal and does not involve all of the fibres of the trunk.

Plexus gangliformis, Pl. nodosus.—The central 5 mm. of the ectocranial trunk are closely apposed to, if not involved in the somewhat intricate net-work of vessels and tissues which characterize this region and form the gangliform or nodose plexus (Fig. Gang.). The apposed trunks of the glosso pharyngeus, the vagus, the accessorius, the hypoglossus, and the sympathic nerves by a peculiar interlacing of fibres and by anastomotic rami sustain intimate inter-relations. There is reason for thinking that through this plexus, the glosso-pharyngeus is connected with the accessorius (the complications involved in identifying rami in this plexus leave some doubt regarding the precise structure of this plexus). The glosso-pharyngeus is ectal in this group and is possibly separable from the ental nerves.

G. petrosum and its Communicating Rami.—At the caudal border of the plexus gangliformis the glosso-pharyngeus presents a fusiform enlargement, the ganglion petrosum (Fig. Pe.), ganglion of Andersch. This is the ganglion of the trunk and is about 2 mm. × 1 mm.; it seems to involve the entire nerve-trunk. Its communicating rami are five, as follows:

1. A large ramus to the dorso-cephalic border of the G. inferius of the N. vagus (Fig. 2). 2. A small ramus to the adjacent sympathic ganglion (G. cervicale cephalicum, Fig. 1). 3. A branch to the plexus, some fibres of which are apparently traceable to the N. accessorius, in the second or large accession from that nerve to the vagus (Fig. 3). 4. A slender filament (Fig. 4) to the auricular branch (Fig. Aur.) which joins the jugular ganglion of the vagus with the geniculate ganglion of the facialis. The auricular ramus crosses the ectal surface of the glosso-pharyngeus just peripherad of the G. ehrenritteri and receives the anastomotic filament from the G. petrosum at a point opposite the nerve-trunk (this filament is frequently broken in dissecting the plexus). These four rami are given off from the ental surface of the G. petrosum as a single trunk or as several closely apposed rami. 5. A large branch, the tympanic (Fig. Tym.) which lies in a fossa entad of the ectal bulla together with a branch from the sympathic. This branch divides in the fossa, into four ramuli, as follows: *a.* One (Fig. Pe. maj.) becomes one of the roots of the great superficial petrosal, which in turn is one of the roots of the vidian nerve. *b.* A second (Fig. Pe. min.) is one of the roots of the small superficial petrosal and terminates in the otic ganglion. *c.* A third (Fig. Eus.) forms a plexus around the eustachian tube. *d.* The fourth (Fig. Pl. tym.) forms, with the sympathic, the tympanic plexus upon the ectal surface of the promontory, from which filaments are traceable to the fenestra rotunda and the F. ovalis.

Principal Rami.—Peripherad of the G. petrosum the nerve-trunk bends around the ventral surface of the ectal bulla and lies apposed to an arteriole, a ramulus from the A. occipitalis. 8 mm. peripherad of the ganglion it gives the first ramus of the trunk (Fig. car.), caudad to the plexus carotideus about the ectal origin of the A. occipitalis. 6 mm. peripherad of this ramus, a branch is sent dorsi-mesad to the sphincter muscles of the pharynx (Fig. M. phar.)—this ramus seems to be the only distinctively muscular branch of this nerve; filaments are also given to the M. stylo-pharyngeus. It is through this ramus that the N. glosso-pharyngeus controls deglutition (the palatal branch, q. v., may possibly reach muscular fibre in the palatal region, corresponding to the M. palato-glossus, and the M. palato-pharyngeus. I have not satisfactorily identified these muscles).

N. pharyngeus.—At the origin of the muscular ramus just described a large ramus, N. pharyngeus (Fig. Phar.), is directed ventrad and caudad; this ramus, about 5 mm. peripherad of its origin, divides into two ramuli, the cephalic one (Fig. Pal.) is distributed to the pharynx in the palatal region; the caudal ramulus forms a dense plexus (Fig. Pl. Phar) with the pharyngeal branch of the vagus nerve (Fig. Phar. Vagus) upon the pharyngeal mucosa laterad of and adjacent to the epiglottis.

A second pharyngeal ramus (Fig. Phar. muc.) is given off 10 mm. peripherad of the first; this is distributed to the mucosa laterad of the base of the tongue. A third branch is given off about 5 mm. still peripherad, which unites in the pharyngeal plexus upon the mucosa.

N. tonsillaris.—About 10 mm. peripherad of the first R. pharyngeus a ramus (Fig. Ton.) is given to the tonsil and to its enveloping capsule. The function of this nerve is not known.

N. papillaris.—The terminal filaments (Fig. Papillæ) may be traced to the long papillæ (circumvallate ?) 15 mm. peripherad of the Os hyoides, upon the base of the tongue. These filaments are in the most restricted sense, the nerves of taste.

Summary.

A. Anatomical.

Ectal Origin.—By 5–6 funiculi in the depression line caudad of the eminentia auditoria, dorsad of the oliva and cephalad of the dorsal roots of the N. vagus.

Foramen of Exit.—Foramen jugulare.

Intercranial Course.—In the passage through the jugular fossa, the N. glosso-pharyngeus is the cephalic one of the structures which traverse the foramen. At the central end of the fossa, the nerve bears a ganglion, the G. ehrenritteri, which is ectal in position and does not involve the entire trunk.

Ectocranial Trunk.—The first 5–7 mm. of the ectocranial trunk are intimately associated with the plexus gangliformis which involves the central portions of the vagus, the accessorius, the hypoglossus, and the sympathic nerves, from which plexus it is generally distinct, although it contributes a considerable ramus (possibly this is an accession to the glosso-pharyngeus from the accessorius). 7 mm. peripherad of the foramen of exit the nerve is involved in a small fusiform ganglion.

G. petrosum and its Communicating Rami.—This fusiform ganglion involves the entire nerve-trunk; it is easily overlooked in the enveloping connective tissue and the adjacent plexus. From its ental surface a single trunk or four adjacent anastomotic rami take their ectal origins as follows: the ventral one to the cephalic cervical ganglion of the N. sympathicus; one just caudad and the largest joins the G. inferius of the vagus nerve; dorsad of this ramus the second in size is given to the plexus gangliformis, a portion of which seems to be traceable to the N. accessorius; the dorsal slender filament joins the ramus auricularis from the root ganglion, G. jugulare, of the vagus to the geniculate ganglion of the N. facialis. From the cephalic border of the ganglion the large tympanic branch, or Jacobson's nerve, lies in a fossa entad of the ectal bulla tympanica adjacent to a branch from the cervical sympathic ganglion. The tympanic nerve divides into four branches as follows: one of the roots of the great superficial petrosal nerve, the principal root of the small petrosal nerve which terminates in the otic ganglion, a slender filament which joins the eustachian plexus, and the branch to the tympanic plexus.

Principal Rami.

1. *Muscular;* a branch to the pharyngeal constrictor muscles (Fig. M. Phar.) has its ectal origin about 14 mm. peripherad of the G. petrosum.

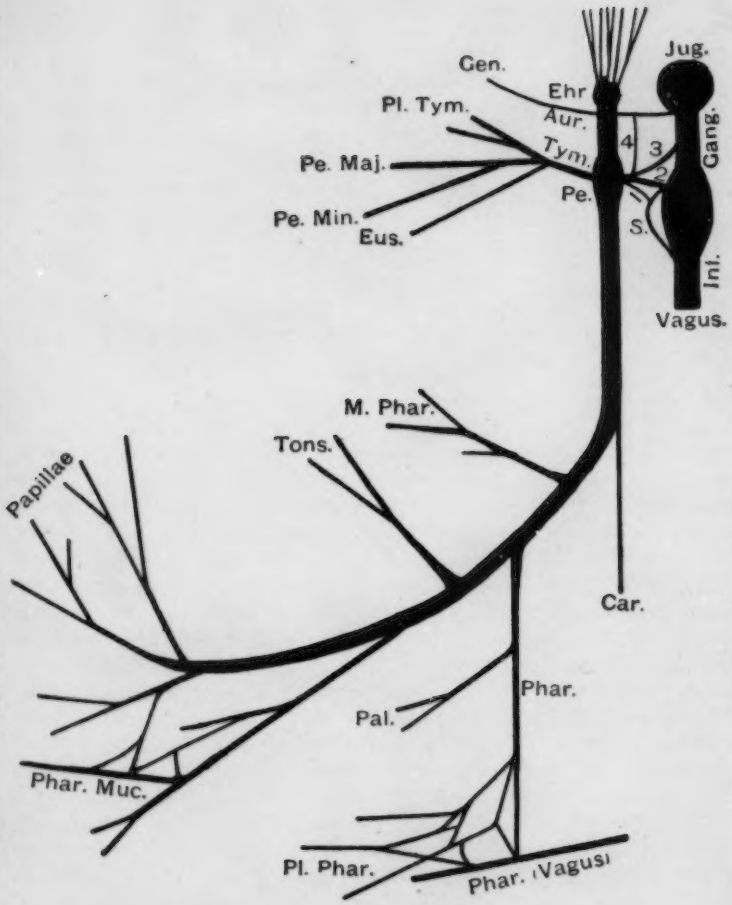

Diagram of the Glosso-pharyngeal Nerve.—Stowell.

2. *Pharyngeal;* three rami from the ventral border of the nerve-trunk to the pharyngeal mucosa.

3. *Tonsillar;* a branch, 10 mm. peripherad of the muscular ramus, to the tonsil and its enveloping capsule.

4. *Terminal;* to the long papillæ at the base of the tongue.

5. *Communicating and anastomotic;*

At the G. petrosum with the G. cervicale cephalicum (sympathicus).
" " " " G. inferius.(vagus).
" " " " plexus gangliformis.
" " " " R. auricularis.
" " " it is the origin of the tympanic nerve (Jacobson).
To the plexus carotideus at origin of the A. occipitalis.
In the plexus pharyngeus with the N. pharyngeus (vagus).

B. Physiological.

The N. glosso-pharyngeus is the sensory nerve of the pharynx; it is the special sense nerve of taste; it controls deglutition, and when abnormally irritated excites an inverted muscular action in the muscles of the stomach and œsophagus, inducing vomiting; it does not seem to be susceptible of painful sensations.

Explanation of the Diagram.

The diagram is not drawn to a scale. It has been the author's aim to present in definite form the principal structures and relations, combining simplicity and clearness. Aur., the auricular branch from the jugular ganglion of the vagus nerve to the geniculate ganglion of the facial. This nerve crosses the ectal surface of the glosso-pharyngeus just ventrad of the root ganglion. Car., the anastomotic nerve to the carotid plexus around the ectal origin of the A. occipitalis. Ehr., the ganglion Ehrenritteri, or ganglion of the root. Eus., the branch which forms with the sympathic a plexus upon the eustachian tube. Gang., the plexus gangliformis, or plexus nodosus. Gen., the position of the geniculate ganglion of the facial nerve. Inf., the ganglion inferius or ganglion of the trunk of the vagus nerve. Jug., the ganglion jugulare or root ganglion of the vagus. M. phar., the muscular ramus to the pharyngeal constrictors. Pal., the branch of the pharyngeal nerve which is distributed to the mucosa in the region of the soft palate, and possibly to the palatal muscles. Papillæ, the terminal filaments of the papillary ramuli which are given to the long papillæ characteristic of the dorsal surface of the base of the tongue. Pe., the ganglion petrosum or ganglion of the trunk. Pe. maj., the branch of the tympanic nerve which becomes one of the roots of the great superficial nerve. Pe. min., the branch of the tympanic which becomes the small petrosal nerve and terminates in the otic ganglion. Phar., the pharyngeal ramus which joins the pharyngeal nerve from the vagus to form the pharyngeal plexus. Phar. muc., the rami which form the plexus over the pharyngeal mucosa. Phar. vagus,

the N. pharyngeus, a branch of the vagus. Pl. phar., the plexus pharyngeus. Pl. tym., the tympanic plexus over the promontory of the tympanum. S., the cephalic cervical ganglion of the sympathic ganglion, just entad and cephalad of the G. inferius. Ton., the tonsillar branch. Tym., the tympanic ramus or Jacobson's nerve. Vagus, the central 10 mm. of the vagus nerve, showing the relations of the ganglia. 1. Anastomotic filament from G. petrosum to S. 2. Communicating branch to the G. inferius. 3. Branch to the plexus gangliformis; this is the doubtful accession from the N. accessorius. 4. Anastomotic filament to the R. auricularis.

Bibliography.

For bibliography consult previous papers. The Trigeminus Nerve in the Domestic Cat; Proceedings of the American Philosophical Society, Vol. xxiii, pp. 459–478; 1886. Also, The Facial Nerve in the Domestic Cat; Proceedings of the American Philosophical Society, Nov. 5, 1886.

The Accessory Nerve in the Domestic Cat. *By T. B. Stowell, A.M., Ph.D.*

(*Read before the American Philosophical Society, March 2, 1888.*)

Synonymy.—N. accessorius; Accessory of the Par Vagum; Accessory nerve of Willis; Spinal accessory; Superior respiratory; Eleventh pair of encephalic nerves.

General Characters.—This nerve is called accessory because of its large accessions to the N. vagus, in the G. jugulare and in the plexus just peripherad, v. description below; it is called myelic and spinal from the fact of its widely distributed origin along the cervical myel, v. below. The nerve is an attractive study alike to the anatomist and to the physiologist; its origin, distribution, terminal plexuses and its action upon respiratory movements, laryngeal phonation and the heart are equally distinctive. It combines a large group of myelic funiculi with a few from the medulla; by virtue of its accessions to the Vagus it sustains structural relations with the N. pharyngeus and with the N. laryngeus caudalis (Rami of the Vagus), indeed a large share of the motor fibres of the Vagus is referable to the accessions from the Accessorius [Longet, Système Nerveux, t. ii, p. 265; Cl. Bernard, Leçons sur la Physiologie du Système Nerveux, t. ii, p. 244]; by an anastomotic ramus it joins the N. hypoglossus, and in its terminal filaments it makes numerous plexuses with the cervical myelic nerves. M. Claude Bernard by his method of evulsion demonstrated that laryngeal phonation is due to the action of the accessory nerve. The prolonged cries of many mammals seem to confirm his conclusions and are due, in part, at least, to the rigidity of the cervical muscles in sustained expiratory movements. According to Heidenhain, this accession gives cardio-inhibitory fibres to the Vagus.

Description.

Ectal Origin and Entocranial Course.—The N. accessorius is peculiar in its two-fold origin, the medulla and the myel; the cephalic roots arise in the depression line dorsad of the area ovalis and immediately caudad of the dorsal roots of the N. vagus; the caudal roots arise along the lateral column of the cervical myel, as far caudad as the fifth cervical vertebra (fibres are not infrequently traceable along the entire cervical myel). The confluence of these funiculi forms a nerve trunk whose volume increases from its caudal origin to the foramen of exit. The nerve trunk thus constituted lies entad of the myelic dura opposed to the lateral column of the myel, between the dorsal and the ventral roots of the myelic nerves; its course is cephalad and enters the cranium through the foramen magnum; at the caudal border of the ectal roots of the N. vagus, the N. accessorius turns laterad and perforates the dura just caudad of the Vagus (I have not met with two entocranial trunks, as is sometimes the case in man), and takes its exit from the cranium through the foramen jugulare in the common sheath with the Vagus and the adjacent Glossopharyngeus.

Just centrad of the foramen of exit the Accessorius is closely opposed to the G. jugulare (Vagus), to which ganglion it gives a large ramus. This is the so-called accessory or motor root of the N. vagus.

Intercranial Relations and Foramen of Exit.—The N. accessorius traverses the jugular fossa, in which it lies caudad and laterad of the N. vagus, but apparently in a common sheath with that nerve (additional histological research may disclose a separate sheath for each nerve), and leaves the cranium by the foramen jugulare.

Ectocranial Trunk.—The first 5–10 mm. of the ectocranial trunk are involved in the dense plexus, Pl. gangliformis or Pl. nodosus (Fig. Plexus), with the Vagus. This plexus is formed by interlacing fibres of the Vagus, the Accessorius, a few fibres from the Hypoglossus, with numerous embracing and intertwining filaments of the N. sympathicus, and the vessels of this region; it is highly probable that the adjacent N. glossopharyngeus with its G. petrosum is involved in this plexus.

Peripherad of the plexus, the N. accessorius lies entad of the A. occipitalis and the V. jugularis (a ramule of the A. occipitalis is dorsi-laterad of the nerve in its ecto-cranial course as far as the A. occipitalis). At the caudal border of the A. occipitalis, the Accessorius bends dorsi-caudad, accompanied by a small arteriole and perforates the M. clavo-mastoideus near its dorsal border, 20–25 mm. caudad of the insertion of the muscle; this point is also dorsad of the cephalic end of the thyroid body.

Principal Rami.

N. clavo-mastoideus.—As the Accessorius perforates the M. clavo-mastoideus a large ramus (Fig. Clv.-Mas. ca.) is given to that muscle; it is accompanied by an arteriole, lies upon the ental surface of the muscle,

and may be traced to the caudad extremity (origin) of the muscle, where it is joined by the anastomosing filaments of the cervical nerves (Fig. Crv.). From the dorsal border of the nerve at nearly the same point a corresponding ramus (Fig. Clv.-Mas. ce.) is given to the cephalic end (insertion) of the same muscle; this ramus also innerves the adjacent cephalic extremity of the M. sterno-mastoideus (Fig. Str.-Mas.).

N. sterno-mastoideus.—Upon the ectal surface of the M. clavo-mastoideus a large ramus from the Accessorius enters the ental surface of the superposed sterno-mastoid muscle. *The shorter or dorsal division* of this ramus (Fig. Ster.-Mas. ce.) lies ectad of the trunk of the Accessorius and supplies the cephalic (insertion) third of the muscle, or that portion cephalad of the point of init of the nerve; *the ventral division* (Fig. Str.-Mas. ven.) is distributed to the thick ventral border of the caudal two-thirds of the same muscle. About 5 mm. peripherad, or at the dorsal border of the M. sterno-mastoideus, where the muscle is crossed by the large trunk of a cervical nerve (2°), a second ramus (Fig. Str.-Mas. dors.) is given from the Accessorius to the thin dorsal border of the caudal portion of the same muscle. This ramus lies ectad of the cervical nerve and receives from it a large accession. Since this muscle has two sources of nerve-supply, there is throughout the caudal portion of the muscle a more or less frequent anastomosis of terminal filaments.

N. clavo-trapezius cephalicus.—This ramus is given off in connection with the dorsal ramus of the N. sterno-mastoideus; it lies entad of an artery which supplies the cephalic 20 mm. of the M. clavo-trapezius. The nerve enters the ental surface of the ventral border of the muscle, with the artery just named, and sends a ramulus 5–10 mm. caudad of the artery and is distributed to the cephalic fourth of the muscle; the terminal filaments of the nerve may be traced to the dorsi-meson. Near its ectal origin this nerve receives an anastomotic branch from the second cervical nerve.

The main nerve trunk lies entad of the M. clavo-trapezius, crosses the ectal surface of the M. levator claviculæ and continues dorsad of the levator muscle upon the ectal surface of the M. splenius. At the ventral border of the M. clavo-trapezius the N. accessorius receives a large branch from the second cervical nerve which crosses its ectal surface in this region. At the dorsal border of the M. levator claviculæ it sends a slender ramus (Fig. Spl.) to the cephalic portion of the M. splenius.

N. clavo-trapezius caudalis.—About the middle of the M. clavo-trapezius, a large ramus, the N. clavo-trapezius caudalis, separates from the Accessorius and divides into three or four ramuli which enter the ental surface of the M. clavo-trapezius to be distributed to that portion of the muscle which lies dorsad of the M. levator claviculæ.

Between the clavo-trapezius and the acromio-trapezius muscles, upon the side of the neck, and dorsad of the levator muscle, is a narrow intermuscular interval, the *hiatus trapezii* (Fig. Hi.), filled with adipose, connective tissue, a large lymphatic, an artery, the accessory nerve and the cervical plexus of the second and third myelic nerves.

N. acromio-trapezius.—In this hiatus a large ramus (Fig. caudad of Hi.) is sent dorsad to the M. acromio-trapezius, which enters the cephalic border of the muscle and is distributed by 3–4 terminal ramuli to the dorsal portion of the muscle; caudad of the hiatus several (two shown in diagram) rami from the Accessorius enter the ental surface of the muscle.

Caudad of the hiatus (about 5 mm.) a large accession (Fig. Crv.) is received by the N. accessorius, from the cervical plexus. This nerve (myelic) accompanies the artery which appears in the hiatus.

The nerve trunk terminates upon the M. spino-trapezius. The tendon ectad of the *Delta mesoscapulæ* marks the caudal border of the acromio-trapezius muscle and the cephalic border of the spino-trapezius; entad of the ventral angle of this tendinous fascia is found the caudal continuation of the N. accessorius, now designated as the spino-trapezius nerve.

N. spino-trapezius.—At the cephalic border of the M. spino-trapezius, the accessory nerve divides into dorsal and ventral rami which may be traced throughout the muscle. Since the muscle is innerved by the thoracic nerves (myelic) as well as by the terminal rami of the Accessory, the terminal filaments of both nerves form an open plexus throughout its tissue.

Summary.

A. Anatomical.

Ectal Origin.—The N. accessorius arises from the lateral column of the cephalic myel and the caudal medulla dorsad of the area ovalis; the myelic roots are apparent as far caudad as the sixth or seventh cervical vertebra.

Entocranial Course.—The aggregation of these numerous roots forms a nerve-trunk which increases in volume from the caudal origin cephalad to the foramen of exit; the trunk is apposed to the lateral column of the myel, lies entad of the dura between the dorsal and the ventral roots of the myelic nerves, enters the cranium through the foramen magnum and extends cephalad in the cranium to the caudal roots of the N. vagus, where it perforates the dura and is associated with the vagus and the glosso-pharyngeus nerves in the foramen of exit.

Foramen of Exit.—The N. accessorius traverses the foramen jugulare with the associated vagus and accessorius nerves, the jugular vein and a small arteriole, a ramulus from the A. occipitalis.

Communicating Rami.

1. Accession to the G. jugulare (Vagus) centrad of the foramen of exit.

2. Several rami to the Plexus gangliformis, 5–10 mm. peripherad of the foramen jugulare (the first of these is the probable accession to the N. glosso-pharyngeus).

3. Accession to the G. inferius (Vagus).

4. With cervical nerves.

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Principal Rami—their Ectal Origins and Distributions.

N. clavo-mastoideus.

1. *Caudal ramus;* origin at the ental surface of the M. clavo-mastoideus as the nerve perforates the muscle.

2. *Cephalic ramus;* origin opposite the dorsal border of the muscle. These rami are distributed to the caudal and the cephalic portions of the muscle respectively.

N. sterno-mastoideus.

1. *Dorsi-cephalic ramus;* origin at the ectal surface of the M. clavo-mastoideus, distribution to the cephalic third of the muscle.

2. *Ventral ramus;* origin in common with the preceding, distribution to the thick ventral two-thirds of the muscle.

3. *Dorsi-caudal ramus;* origin at the dorsal border of the M. sterno-mastoideus in connection with the cephalic clavo-trapezius nerve, distribution to the thin dorsal border of the caudal two-thirds of the muscle.

N. clavo-trapezius.

1. *Cephalic ramus;* origin in common with the dorsi-caudal ramus of the sterno-mastoid nerve, distribution to the cephalic fourth of the M. clavo-trapezius; this nerve joins its platetrope in the dorsi-meson.

2. *Caudal ramus;* origin about the middle of the M. clavo-trapezius, distribution by 3–4 palmate ramuli to the ental surface of the caudal portion of the muscle.

N. acromio-trapezius.

1. *Cephalic ramus;* origin in the Hiatus trapezii, distribution to the cephalic portion of the acromio-trapezius muscle; this is the large nerve and extends to the dorsi-meson.

2. *Other rami;* several (two prominent) other rami supply the caudal portion of the muscle.

N. spino-trapezius.

The terminal rami of the Accessorius unite with the thoracic myelic nerves in an open plexus to the M. spino-trapezius.

Myelic Accessions.

Two large accessions from the myelic nerves are received by the trunk of the Accessorius, the *cephalic* is just caudad of the cephalic clavo-trapezius nerve, the *caudal* is just caudad of the hiatus-trapezii.

B. Physiological.

The N. accessorius is the motor nerve of the sterno-mastoid, the clavo-mastoid, and the trapezius muscles; it is possibly the source of the motor fibre of the Vagus nerve; it seems to be exclusively motor; its distribution and physiological experiments indicate the absence of sensibility; it is antagonistic to movements of respiration (Cl. Bernard); it controls laryngeal phonation (Cl. Bernard); it is cardio-inhibitory (Heidenhain).

Explanation of Diagram.

The diagram seeks to present the principal rami and relations of the nerve. Actual measurements and perspective are sacrificed to clearness

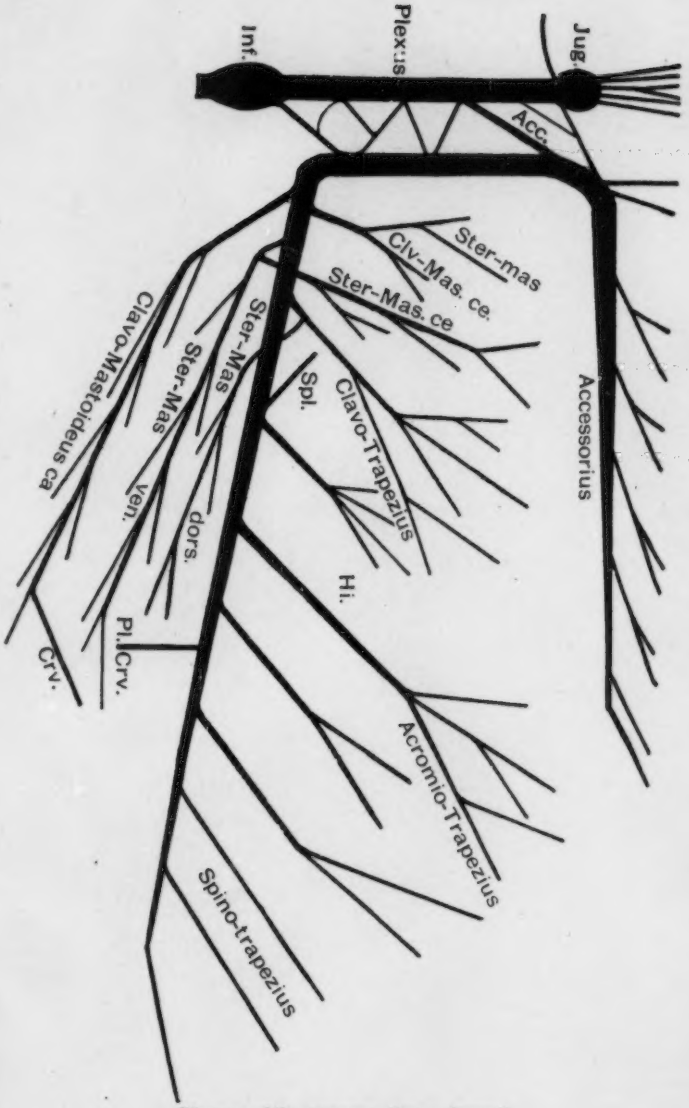

Diagram of the Accessory Nerve.—Stowell.

and simplicity, *e.g.*, the dorsal rami are laterad and the terminal filaments are dorsad of the line of origin, which relation is not shown.

Acc. Accessions from the N. accessorius to the N. vagus, etc. Acromio-trapezius, the three rami to the M. acromio-trapezius.

Clavo-mastoideus, ca., the caudal ramus of the clavo-mastoid nerve. Clv.-mas. ce., the cephalic ramus of the same. Clavo-trapezius, the two principal rami to the M. clavo-trapezius. Crv., cervical myelic nerve. Hi., the hiatus trapezii. Inf., the ganglion inferius. or ganglion of the trunk of the N. vagus. Jug., the G. jugulare of the same nerve. Plexus, the gangliform plexus of the Glosso-pharyngeus, the Vagus, the Accessorius, the Hypoglossus, and the Sympathic nerves. Pl. Crv., the cervical plexus from which the accession is given to the N. accessorius near the hiatus. Spino-trapezius, the rami given to the M. spino-trapezius. Spl., the branch to the M. splenius. Ster.-mas., ramus to the cephalic extremity of the M. sterno-mastoideus. Ster.-mas. ce., ramus to the same. Ster.-mas., dors., ramus to the dorsal border. Ster.-mas., ven., ramus to the ventral border of the same muscle.

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For bibliography consult the Trigeminus Nerve in the Domestic Cat. T. B. Stowell. Proceedings of the American Philosophical Society, Vol. xxiii, pp. 459–478, 1886. Also, The Facial Nerve in the Domestic Cat. T. B. Stowell. Proceedings of the American Philosophical Society, Nov. 5, 1886.

The Hypoglossal Nerve in the Domestic Cat. By T. B. Stowell, A.M., Ph.D.

(*Read before the American Philosophical Society, March 2, 1888.*)

The reasons for presenting this contribution to comparative neurology have been given elsewhere. (The Facial Nerve in the Domestic Cat. Proceedings of the American Philosophical Society, Nov., 1886.) The preparation of specimens and the magnifying powers used are described in the same paper.

Nervus hypoglossus.

Synonymy.—N. hypoglossus ; N. lingualis medius ; Par nonum ; N. loquens ; Hypoglossal nerve ; Gustatory nerve ; Ninth pair of nerves.

General Characters.—The N. hypoglossus is the motor nerve of the tongue and of muscles that move the hyoid bone. By virtue of its relation to the tongue it is directly concerned in mastication, since by the movements of the tongue successive morsels of food are thrust between the teeth or are moved preliminary to deglutition. Its function is further shown by those mammals whose food is largely liquid and is secured

by lapping, in which animals the prehension of food is impossible after section of the N. hypoglossus. Longet's experiments upon the entocranial trunk after section demonstrated the presence of excitability without sensibility; Mayo and Magendie proved the presence of sensibility in the ectocranial nerve. We are forced to accept a mixed function in this nerve or to attribute its sensibility to the accessions from the myelic nerves.

The section of the N. hypoglossus destroys movements of the tongue without disturbing the tactile or the gustatory sensibility [Longet, Anatomie et Physiologie du Système Nerveux, t. ii, p. 266].

The sensibility of the hypoglossus seems to be muscular rather than mucosal. Since the section of the N. vagus and the N. glosso-pharyngeus is attended by loss of sensibility over the entire surface or dorsum of the tongue, although the N. hypoglossus is intact. Panizza's experiments, confirmed by later observations, establish the paralysis of the pharyngeal muscles involved in deglutition by severing the N. hypoglossus. The vaso-motor function of the N. hypoglossus is seen in the dilatation of the vessels of the tongue when the nerve is severed; it is questionable whether the fibres to which this function is referable are not received from the myelic or the sympathic nerves.

The connection of the N. hypoglossus with distinct articulation is demonstrated by experiment and confirmed by pathological evidence. The prominent role in pronunciation performed by the tongue evinces the importance of this nerve in expressing thought by articulate language.

Description.

Ectal Origin and Entocranial Relations.—The N. hypoglossus has its ectal origin by several (12–16) funiculi along a depression line about 4 mm. laterad of the ventri-meson, and which marks the dorsal border of the caudal half of the area elliptica; these funiculi are grouped into two more or less distinct bundles which are separated by the first dorsal ramulus of the A. cerebellosa caudalis. The cephalic bundle embraces 8–12 funiculi (when the arteriole is represented by two vessels this cephalic bundle is again divided into two nearly equal portions); the caudal bundle includes about 6 funiculi, the caudal funiculus having its ectal origin at the cephalic border of the ventral root of the first cervical nerve, just entad of the A. cerebellosa.

The ectal origin resembles the ventral root of a myelic nerve.

Foramen of Exit.—The confluence of these funiculi forms a nerve trunk, which takes its exit by the foramen condylare.

Ectocranial Trunk.—The ectocranial course is immediately caudad, lies dorsad of the A. carotidea and entad of the V. jugularis as far as the A. occipitalis. The central 5–8 mm. of the ectocranial trunk are intimately involved in the gangliform plexus (Fig. Pl. gang.) which is made by the interlacing fibres of the associated glosso-pharyngeus, vagus, acces-

sorius, hypoglossus and sympathic nerves. Peripherad of the plexus the N. hypoglossus bends abruptly around the caudal border of the A. occipitalis (Fig. Ang.) and crosses the ectal surface of the N. vagus just cephalad of the G. inferius (vagus), also crosses the ectal surface of the A. carotidea and lies upon the ectal surface of the A. lingualis, which it crosses twice (the artery being the more sinuous), first about 8 mm. peripherad of the origin of the artery (A. lingualis), and again 10–12 mm. still peripherad. This portion of the trunk lies entad of the M. stylo-hyoideus, along the caudal border of the M. digastricus.

Communicating Rami of the Trunk.—At the angle (Fig. Ang.) a considerable accession is received from the first cervical nerve (myelic, Fig. Anas.); it is possible that this accession is the true origin of the cervico-hypoglossal nerve. (The minute anatomy of this region has not been satisfactorily determined.) Just cephalad of the G. inferius, and peripherad of the plexus a large ramus (Fig. Inf.) joins the ganglion at its dorso-cephalic border.

Principal Rami.

N. cervico-hypoglossus; N. cervicalis descendens; N. descendens noni.—At the angle (Fig. Ang.) where the accession is received from the myelic nerves, as the hypoglossus curves around the A. occipitalis, the N. cervico-hypoglossus takes its ectal origin. An anastomotic nerve joins the myelic nerve and this trunk (Fig. Anas.). The existence of this anastomosis makes it debatable whether the cervico-hypoglossus should be considered a ramus of the N. hypoglossus having a myelic accession, or a myelic nerve having a large accession from the N. hypoglossus. I have adopted the compound name applicable to either of the views cited.

The course of the nerve is ventro-caudad, and is at first entad of the jugular vein; it reaches the carotid artery about 7 mm. caudad of the A. occipitalis and continues caudad upon the ectal surface of the artery about 12 mm. to the origin of the A. thyroidea.

N. omo-hyoideus.—At the origin of the A. thyroidea, a large ramus is given off ventrad (Fig. Om-Hy. ce.). This ramus lies ectad of the artery and innerves the cephalic 25 mm. of the M. omo-hyoideus. The caudal portion of the muscle is innerved by a ramus of the N. cervico-hypoglossus which takes its ectal origin at the point where the nerve trunk touches the dorsal border of the M. sterno-thyroideus. This slender caudal ramus crosses the ectal surface of the sterno-thyroid muscle, enters its dorsal border and may be traced within the muscle to the præsternum* (Fig. Om-Hy. ca.).

N. sterno-thyroideus.—Caudad of the A. thyroidea the cervico-hypoglossus lies in the ental cervical fascia, ectad and ventrad of the A. carotidea.

* The origin of the M. omo-hyoideus is costal instead of scapular, as is the case in man; the general relations are such that little doubt can exist as to the homology of the muscle.

At a point opposite the cephalic extremity of the thyroid body, the nerve-trunk sends a slender ramus, the *cephalic* sterno-thyroid (Fig. St.-Thy. ce), to the cephalic third of the M. sterno-thyroideus : the *caudal* ramus (Fig. St.-Thy. ca.) is the caudal 50–60 mm. of the N. cervico-hypoglossus, and may be said to have its ectal origin at the origin of the ramus to the caudal portion of the M. omo-hyoideus or at the point where the nerve trunk lies upon the dorsal border of the sterno-thyroid muscle ; it follows the border of the muscle for about 20–30 mm., when it penetrates the muscle and terminates within the caudal extremities (origins) of the muscles (sterno-hyoid, omo-hyoid, sterno-thyroid), which have a common origin from the lateral border of the præsternum and the first costal cartilage.

Opposite the caudal extremity of the thyroid body the cervico-hypoglossal nerve is joined by a communicating ramus (Fig. communicans) from the adjacent cervical plexus or loop. This is the N. communicans noni. This branch does not seem to be constant.

N. thyro-hyoideus.—The ectal origin of this ramus is entad of the V. jugularis, immediately peripherad of the origin of the cervico-hypoglossal nerve ; its course is parallel to the latter nerve and ventrad of it ; it crosses the ectal surface of the A. carotidea at the origin of the A. laryngea cephalica, whence it bends ventrad and lies caudad of the artery and cephalad of the N. laryngeus internus ; it innerves the M. thyro-hyoideus (Fig. Thy.-Hy.) and sends two terminal ramuli to the M. sterno-hyoideus, a *cephalic* ramulus to the cephalic portion, a *caudal* one to the caudal portion of the muscle. This nerve joins its platetrope in the ventri-meson.

N. stylo-glossus.—About 15 mm. ventrad of the A. carotidea the A. lingualis gives an arteriole to the M. stylo-glossus ; centrad of this arteriole the hypoglossus nerve sends a branch, the N. stylo-glossus, to the muscle having the same name. The nerve lies upon the ectal surface of the M. hyo-glossus ; at the ventral border of the stylo-glossus muscle it separates into a leash of terminal ramuli which intercommunicate by anastomotic filaments upon the muscle (Fig. Sty.-Gloss.).

N. hyo-glossus.—5 mm. peripherad of the last nerve the hyo-glossal nerve (sometimes 3–4 ramuli from a common trunk, or more frequently separate nerves) is given to the fibres of the M. hyo-glossus. The nerve crosses the ectal surface of the A. lingualis. The terminal filaments intercommunicate and form a loose plexus (Fig. hyoglossus) with the N. lingualis (R. of N. trigeminus), which in this region lies upon the ectal surface of the ranine artery.

N. genio-hyoideus.—At the dorsal border of the M. genio-hyoideus, the N. hypoglossus curves cephalad and follows the general direction of the genio-hyoid muscle, to which it gives from its ventral border the N. genio-hyoideus, which nerve may be traced 20 mm. cephalad in the muscle (Fig. Gen.-Hyoid).

N. genio-hyo-glossus.—Peripherad of the border of the M. genio-hyoideus, the N. hypoglossus bends mesad around the A. lingualis and lies entad of the artery. As it curves around the artery it gives from its ven-

tral border several filaments to the M. genio-hyo-glossus (Fig. Ge-hy-gl.); these filaments by their interlacing form a terminal plexus.

N. lingualis.—The hypoglossal nerve follows the artery along its ental border and supplies terminal filaments to distal 30 mm. of the tongue (Fig. Ter.).

Summary.

A. Anatomical.

Ectal Origin.—The nerve arises by 12–16 funiculi along a line 4 mm. laterad of the ventri-meson, which line marks the dorsal border of the caudal half of the area elliptica. The origin is nearly surrounded by arterioles from the A. cerebellosa.

Foramen of Exit.—Foramen condylare.

Principal Rami, their Origins and Distributions.

1. *N. cervico-hypo-glossus* (descendens noni); origin at the angle as the nerve bends around the A. occipitalis, distribution to the M. omo-hyoideus and to the M. sterno-thyroideus.
2. *N. thyro-hyoideus;* origin immediately peripherad of the last nerve, distribution to the M. thyro-hyoideus and to the M. sterno-hyoideus.
3. *N. stylo-glossus;* arises at a point 15 mm. ventrad of the A. carotidea, distribution to the M. stylo-glossus.
4. *N. hyo-glossus;* origin (2-3 rami) 5–10 mm. peripherad of the last nerve, distribution to the M. hyo-glossus; joins the N. lingualis in a plexus.
5. *N. genio-hyoideus;* origin at the dorsal border of the M. genio-hyoideus, to which muscle it is distributed.
6. *N. genio-hyo-glossus;* origin as the nerve trunk bends around the lingual artery.
7. *N. lingualis;* terminal filaments to the distal 30 mm. of the tongue.

Communicating Rami.

1. To the cervical sympathic ganglion.
2. To the N. vagus in the plexus gangliformis and in the G. inferius.
3. A large accession at the *angle* from the first myelic nerve.
4. The communicans noni to the N. cervico-hypoglossus.
5. With the N. lingualis (R. of N. trigeminus) in the terminal plexus.

B. Physiological.

The N. hypoglossus is the motor nerve of the tongue; it innerves several muscles which move the os hyoides; it is directly related to mastication and to deglutition; it is essential to distinct articulation; in function it is possibly a mixed nerve, the sensibility however is referred by some physiologists to the accessions from the myelic nerves; it possesses vasomotor fibres, which are possibly derived from the communicating rami.

EXPLANATION OF DIAGRAM.

Anas., anastomotic ramus from first myelic nerve; this is the disputed origin of the N. cervico-hypoglossus. Ang., the angle where the N. hypoglossus bends around the A. occipitalis. Ca., caudal ramus. Ce., cephalic ramus. Communicans, a myelic accession, the communicans noni. Crv., myelic nerves. Gen-Hyoid, the genio-hyoid muscle. Ge-Hy-Gl., the genio-hyo-glossal muscle. Hyoglossus, the hyo-glossal muscle. Inf., the ramus to the G. inferius of the N. vagus. Lingualis, the lingual nerve of the mandibular division of the N. trigeminus. Om-Hy., the M. omo-hyoideus. Pl. car., anastomotic filament to the carotid plexus. Pl. gang., the plexus gangliformis. Sty-Gloss., the stylo-glossus muscle. St-Thy., the M. sterno-thyroideus. Thy-Hy., the M. thyro-hyoideus.

Aboriginal Pottery of the Middle Atlantic States.

By Francis Jordan, Jr.

(*Read before the American Philosophical Society, March 2, 1888.*)

In the whole range of archæology there are few subjects deserving of more thoughtful consideration, or that possess so many instructive and entertaining features as the study of ceramic art as practiced by primitive man. Its development is contemporary with the progress of civilization, and dates from the earliest period of antiquity, beginning with the manufacture of earthenware of the rudest description, exclusively for culinary purposes, from materials that were too obvious even for the semi-barbarian to overlook. The brief paper I have the pleasure of offering for your consideration is restricted to a discussion of but one of the many branches of this interesting study, namely, the characteristic features of the prehistoric pottery of the Middle Atlantic States, of North America, and the conditions under which it has been recovered.

In its fabrication as in all the departments of aboriginal domestic labor, the work was performed by women, who gave to these rude vessels whatever claim to artistic merit they possess, of which the relics of the mound-builders of the Mississippi valley furnish the best examples.

In form, in decoration, and in the use of pigments, and in their construction, these specimens rank with the early productions of the potters of the old world, a superiority that was doubtless the result of contact with the advanced civilization of the Pacific Coast, and a reproduction of its ceramic forms. The pottery of the Atlantic seaboard is more primitive in its character, and denotes, both in design and decoration, a more remote antiquity, a claim, however, that cannot be established if we accept Indian tradition as authority for the belief that the influx of emigration was from

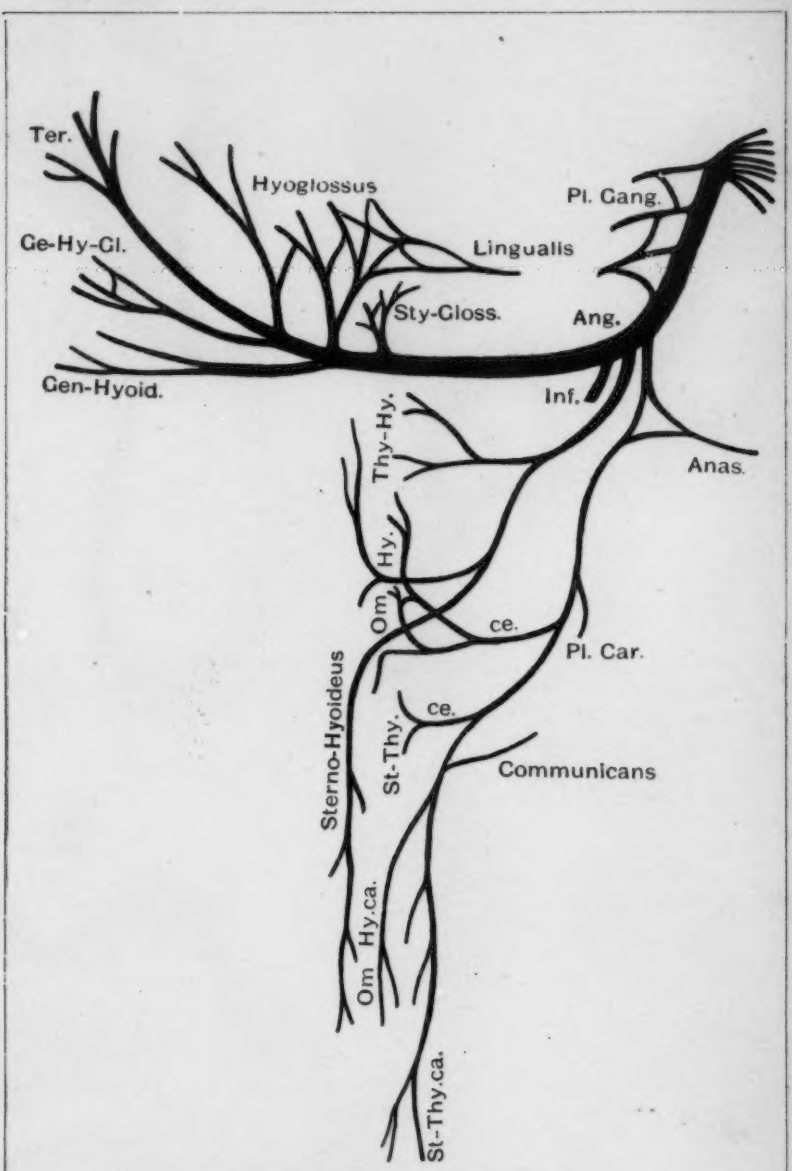


Diagram of the Hypoglossal Nerve.—Stowell.

the West. But it is hardly within the scope of this brief paper to enter into a discussion of the comparative ages of the pottery of the two sections. In view of the very limited number of perfect specimens which have their origin in the Middle Atlantic States, a thoroughly satisfactory treatise of the earthenware of that locality, omitting all other considerations, is hardly within the realm of possibility.

It may surprise those unacquainted with the data, to learn that the entire number of unbroken vessels will not exceed twenty-five, and of these the largest proportion, as well as the most remarkable, was found in Pennsylvania. On the other hand, many hundreds of the most valuable specimens have been recovered in perfect condition from the ancient earthworks and sepulchral mounds in the district beyond the Alleghanies. In some instances these tumuli are of vast proportions, but in the absence of sufficient evidence on which to form anything like an accurate opinion, their antiquity must remain a matter of conjecture. With their identity established, and with the knowledge that the American Indians, following a custom almost universal among semi-barbarous nations, deposited articles of earthenware with the dead, these ancient tombs may be explored without subjecting their contents to accidental destruction.

In the Middle Atlantic States, however, where this mode of sepulture rarely obtained, and where an Indian grave has no visible existence, its discovery is usually one of chance, and then almost invariably made by the plough, a medium very apt to efface all traces of its prehistoric character.

Incredible as it may appear, I am informed by Dr. Charles Rau that the National Museum, at Washington, within two years did not contain a single perfect specimen from the Eastern and Middle States in its archæological collection. In 1878 Prof. E. Hitchcock, of Amherst, Mass., sent to the National Museum colored plaster casts of three clay vessels found in New England. The most remarkable of them is figured in Vol. v, page 14, of the *American Naturalist*. This vessel, together with the largest of the three sent, is in the collection of the University of Vermont, at Burlington. The original of the third cast is in the possession of Mr. George Sheldon, Deerfield, Mass., who found it in the lot adjoining his home. "I know of but one other vessel of this nature," says Prof. Hitchcock, "ever found whole in New England. This is in the hands of Dr. S. A. Green, of Boston." The pottery of New Jersey possesses no distinctive features, if we are to be guided by the two or three unbroken vessels that have been uncovered within her borders. Dr. Abbott figures but one in his "Stone Age" of that State.

Delaware is even more disappointing, as she has thus far failed to contribute a single specimen to aid us in our comparative examination. On the banks of nearly all her water-courses are to be seen refuse shell deposits, many of them of considerable size, and all of great age, indicating a population more dense than any of her sister States. Mingled with the remains of these deserted villages are large quantities of broken pottery, but the fragments are those of coarse and generally undecorated pots that have

succumbed to hard usage, and in that condition consigned to the refuse heap. An unbroken specimen has never been found, and of the sherds, the largest that I have seen was the base of a pot unearthed near Felton, where I found it serving the purposes of a soap dish. Extreme plainness characterized the pottery of this State. In capacity they were scarcely more than quart pots, shaped like the gourd, with decorations of the simplest description, of which the most elaborate were those having incised parallel lines encircling the rim.

It is gratifying to be able to say that it has been reserved for Pennsylvania to furnish the best examples of this ancient industry. The Wyoming Historical and Geological Society, of Wilkesbarre, with commendable zeal, under the enthusiastic direction of the late Harrison Wright, succeeded in locating several Indian graves in Luzerne county, from which were exhumed nine very remarkable perfect specimens. These have been carefully described and figured in the Proceedings of that society, and hence it is only necessary to note the fact that although they were all found within a radius of twenty miles, there are no two identical in shape, and each has a different ornamentation.

Two more from the same State have been deposited in the museum of the Historical Society of Pennsylvania, very similar in form and decoration to those found near Wilkesbarre, which, with another discovered in the mountains near Summit Hill, constitute a distinct, and what I shall call the Pennsylvania variety, of which the high square decorated mouth is a prominent characteristic. These pots were made to contain from a half to one gallon, and are very much larger, as they are also the most beautiful of the mortuary pottery heretofore described.

In construction, design and decoration, very marked differences distinguish the specimens from the States under discussion, and in considering this part of the subject it is necessary to treat first the large undecorated vessels, evidently intended to withstand rough handling, of which the clay is thick—from a half to one inch—and the materials coarse. In appearance this class has a strong resemblance to our modern earthenware, but is heavier and apparently stronger, though actual test may disprove this latter quality. In the other grade we cannot fail to notice a delicacy of construction that pertains alone to the higher class of Indian pottery, upon which patient labor has been expended, producing a highly decorated and carefully finished vessel. Fine sand has been substituted for coarse clay, and the large particles of pounded shell or quartz, which are a conspicuous feature of the rude pots, have been eliminated: the whole showing a more careful preparation.

Of the designs in general it may be said that they occur in an almost endless variety, which in itself is a conceded merit, and one that the potters of the old world did not possess in a greater degree. The difficulties attending the execution of some of the forms is astonishing when we consider that they were made solely for purposes of utility. The prevailing shape was that of the gourd, and like it terminated in a

convex base, which required suspension when in use, for which ears projecting from the rim were provided; and where these did not exist the pot had to be supported when resting upon the earth. I am not aware of the existence of any vessel from this locality having a flat bottom.

In the rude and heavy vessels no deviation was made from the plain lines of the gourd, but in the finer examples the monotony of this form was relieved by flaring or contracting the lips, and in constructing double shoulders.

In some instances the inside, as well as the exterior, was colored a bright red, as if to conceal the inequalities of their rough surfaces, but there is no record of the discovery within the district under consideration of a pot ornamented with colored designs.

Nor are there specimens, so far as I can learn, from the Middle and New England States of bottle-shaped or long necked vases, so frequently met with among the mound relics, and in some sections of the South; and no attempt was made to imitate the human form, or that of birds and animals. The nearest approach thereto, as I have learned from Dr. Rau, are little grotesque human heads or masks stuck on the outside of the vessels below the corners of the rims. A number of fragments thus decorated, which were collected in the State of New York by Mr. F. H. Cushing, are in the National Museum at Washington.

When we consider the difficulties under which these ancient potters wrought their crude materials, the absence of mechanical appliances (unaided by the potter's wheel), their complete ignorance of the first rudiments of artistic knowledge, following only such lines as fancy dictated, we cannot but express amazement at the accura cy of the workmanship and the originality, if not the beauty, of the designs.

It was not the beauty of the trained Grecian or Etruscan schools, but the naturally developed taste of the aboriginee, who sought nature for her models, and found them in the gourd and melon.

Description of Datames magna Hancock. By Joseph L. Hancock.

(*Read before the American Philosophical Society, April 15, 1887.*)

Length 46 mm. (including mandibles); abdomen 24½ mm.; thorax 4 mm.; head 7 mm. Breadth, abdomen 9 mm.; head 10½ mm.; jaws 10½ mm.

Color pale reddish yellowish white, more reddish on head, falces and tips of last joints of legs; paler on abdomen, legs and labial palpi. Last joint (tarsus) of maxillary palpi and longitudinal marking under surface of tibia of the same member, deep brownish-black, fingers of mandibles burnished chestnut-brown, becoming black at points; margin of bristly hairs surrounding base of fingers, reddish-brown.

Cephalic Shield convexed, broader than long, anterior margin nearly straight, outer fourth sloping obliquely outwards and backwards to pos-

terior border, which is rounded ; corner eminences distinct, pale, obtuse, the front border on line with eyes ; shield covered with pale rather long reddish hairs, a bare pale border surrounding shield below, trace of median striæ hardly perceptible.

Eyes slightly elevated, small, front border on line with anterior margin of cephalic plate, encircled with black, pale color with black centre, interval equal to diameter of eye, furnished with hairs, some directed forward longer.

Base of Mandibles together not as broad as head, length of upper surface when closed 5 mm., furnished with numerous stiff reddish bristles of various length, becoming longer at base of fingers, fewer posteriorly, base slightly bulging on outer side, flattened on inner, where there are no hairs except on upper and anterior borders. Upper inner portion extended forward to form fixed finger, 6½ mm. in length, bent slightly outward at base, directed obliquely downward and slightly outward, anterior three-fourths straight, smooth, tapering to point, unarmed, slightly grooved on inner side, which is covered with a brush of long reddish bristly hairs attached to inner side near base, directed forwards, nearly reaching to points. Below the fixed finger is a conical projection armed in front with two rows of teeth, as in figure ; on outer side from above downwards five, first and fifth denticles, second, third and fourth larger and more acute. The second projecting further forward, traces of more points visible continued down on outer margin, teeth covered externally with fringe of reddish hairs. On inner side, largest tooth above projecting fartherest forward than a smaller one, after which follows two small ones with space between, trace of points on inner margin below, teeth tipped with black.

Movable Finger 7 mm., with large acute conical tooth near the base (as in figure), concave behind, convexed in front with point directed upwards and backwards, lying close on inner side is another small conical tooth with point turned more inward and forward, more anteriorly is a small denticle, trace of one midway between. Median carina extending on outer side nearly to point, lower finger set slightly posterior to upper, strongly curved, when closed points pass internal to upper pair, 1 mm. from points, motion vertical, directed from below, inwards, forwards, and slightly outwards, constricted at points, inner side covered with numerous fine feathery hairs continuous with fringe of reddish bristly hairs along inner front margin of base.

Maxillæ directed outwards, upwards and forwards, first joint immovable, bulging, triangular, separated from its fellow on opposite side by deep groove. Elongated on inner margin into a blunt pointed apophysis, surface covered with short pale hairs, second joint short, triangular, with rounded base directed forward, third joint (femur) length 11 mm., longest of maxillary joints, fourth (tibia) 10 mm., fifth (tarsus) 8 mm., length entire 34 mm , femur cylindrical, first half flattened from side to side, enlarged toward extremity. Inner surface of shaft with row of reddish spines of various lengths, increasing in length toward outer end. Tibia more perfectly cylindrical, slightly enlarging toward

extremity, four or five reddish spines forming row on inner portion of shaft, under surface of shaft presenting a longitudinal line of dark brownish-black, becoming wide at extremity; femur and tibia covered with pale yellow hairs, some exceedingly long; tarsus cylindrical becoming slightly swollen at end, color deep brownish-black, thickly set with hairs, some delicate and long, on the under surface very short stumpy hairs appear, extremity furnished with retractile organ covered with a double lip.

Labial Palpus. The first joint of the labial palpus is subcylindrical, nearly as long as first joint of maxilla, to which it is closely adherent, 4½ mm. in length, second joint short cylindrical, trapezoidal in form, third joint same length as second, rhomboidal in form, first three joints together 8 mm., fourth joint more slender, slightly bent, 6 mm., fifth joint 7 mm., sixth joint straight and thinner, 4 mm., seventh joint still thinner and shorter, 3 mm. Anterior surface of first joint clothed with short stiff bristles of reddish color, rest of surface covered with fine pale hairs, as compared to the maxillæ the labial palpi are very slender, shorter by 8 mm. Covered with abundant hairs, some of extreme thinness and silky, quite long.

Thorax small and weak, first segment attached to head closely, pale reddish hairs radiate from this juncture, other two segments appear continuous with abdomen but of shorter diameter, on either side and at point of attachment with head are whitish folds of skin. Each segment sparsely covered with pale hairs. The under surface presents three pairs of basal joints, which are immovable, first pair separated by deep groove from basal plate of labial palpi, separated from each other by a slight median groove, second and third pairs of basal joints closer together, divided from first pair by a deep transverse groove, first pair directed transversely across, second pair inclining obliquely backwards, third pair trifle more obliquely backwards, triangular space left between last pair connecting with abdomen pale whitish.

Legs. First pair of legs 23 mm., shortest stout, first joint short, fixed, quadrangular in outline, rounded, separated by a median indentation from its fellow on opposite side, clothed with short broken-off bristles on anterior surface, second joint same length, subtriangular, short reddish bristly hairs on under surface, third joint longer than second, trapezoidal, bending upwards, fourth joint (femur) longer than third, more cylindrical, bending upwards, fifth joint (tibia) longer and thinner, bends downwards, sixth joint (metatarsus) shorter and weaker than tibia, bends downwards, tarsus one-third as long as metatarsus, two curved palish white claws articulate at extremity, sharp at points which appear red and constricted. Second pair of legs like the first with additional joint wedged in between second and third joints, length 29½ mm. Metatarsus of first feet with row of five short red spines on dorsal surface, one more on outer extremity of tibia which forms a continuous line with the preceding ones, also an imperfect row, three in number on inner side of metatarsus. Metatarsus of second feet with five reddish spines on dorsal surface, continuous with two

at extremity of tibia. Third pair of legs 42 mm., longest. Appendages on under surface pale whitish, of a horny consistence, fan-shaped and attached by foot stalks, ten in number, five on each side, two being adherent to each of the first two, another to each of the third joints, first joint fixed, subtriangular, with base directed obliquely backwards and outwards, equal in length to first pair of basal joints, second joint longer than the basal joint, third joint half the length of the second, fourth joint slightly longer than the third, swollen on under surface changing the direction of the leg slightly backwards, motion being confined to upward movement by first three joints (exclusive of the basal joint), fifth joint (femur) cylindrical and swollen, 10 mm., sixth joint (tibia) more slender, same length, cylindrical, seventh joint (metatarsus) 7 mm. more slender, eighth joint (tarsus) 3½ mm., armed at extremity with two pale-colored claws, regularly curved, with sharp constricted points of red color.

Abdomen. Composed of ten segments increasing in size to middle segments which are 3½ mm. long and 9 mm. wide, slightly decreasing in size posteriorly, first joint bears the genital opening on the under surface which is enclosed by an elevated plate of pale whitish horny substance, orifice triangular, apex directed forward, which is continued into a longitudinal slit, free from hairs, second and third segment each have on middle of posterior border stigmatic openings. The abdomen as a whole is oblong, oval, elliptic in form, convexed about equally above and below, slightly compressed, pale yellowish-white, clothed with velvet of pale whitish hairs on both sides and under parts; trace of broad longitudinal band on upper surface, more naked, beset with pale whitish hairs, band becoming narrower posteriorly, being 6 mm. wide at second joint; under surface of abdomen slightly depressed by a median line, ventral opening a vertical slit 2 mm. in length on last segment, protected on both sides by narrow lips.

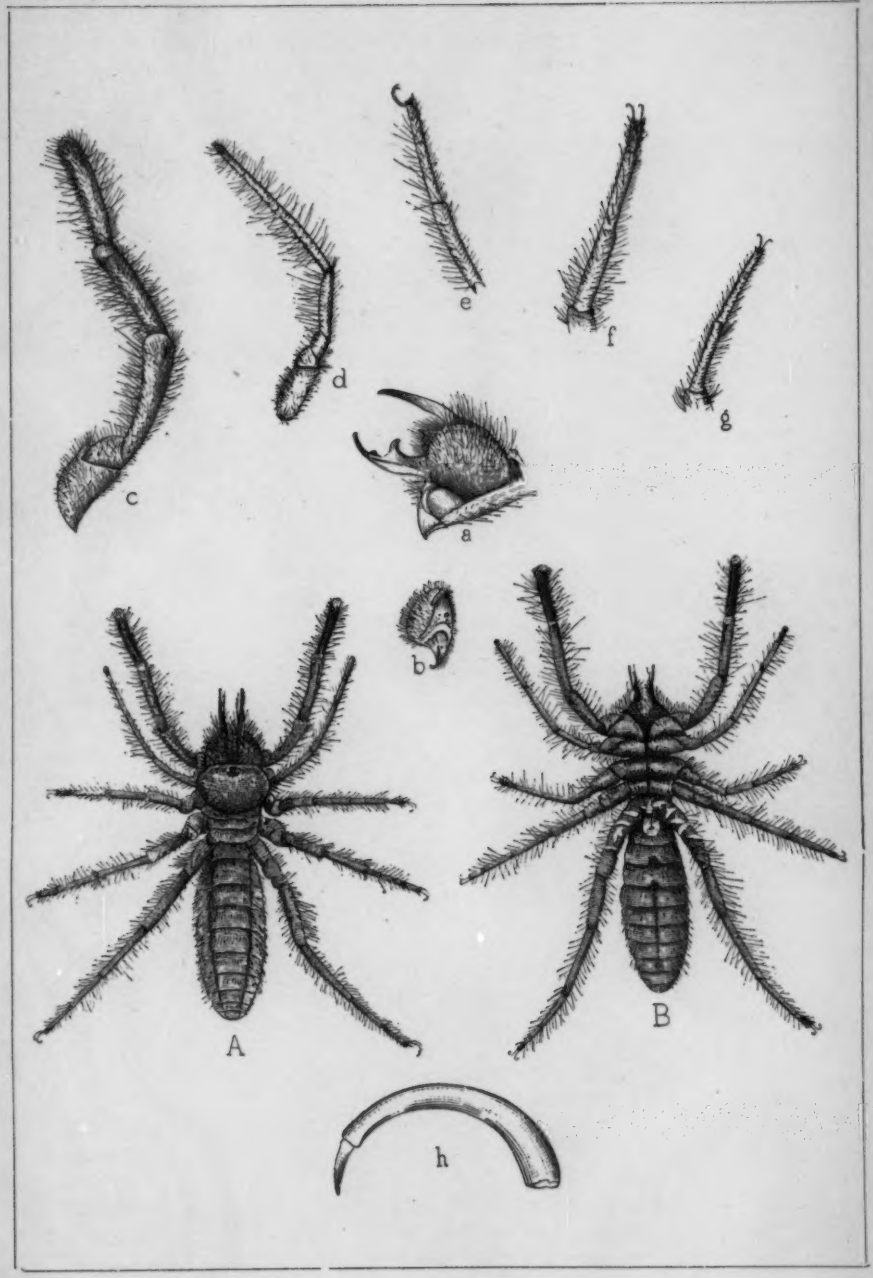
Habitat, Laredo, Texas; taken in 1883.

EXPLANATION OF PLATE.

A. *Datames magna* Hancock, upper surface.
B. Same, under surface.

The following are magnified views:

a. Side view of mandible showing finger and teeth.
b. Front view of mandible showing position of secondary teeth, right side.
c. Maxillary palpus, left side, under surface, showing spines.
d. Labial palpus, left side, under surface.
e. Last three joints of third leg.
f. Last three joints of second leg, showing spines on dorsal surface of metatarsus and tibia.
g. Last three joints of first leg showing spines on dorsal and inner surface of metatarsus and tibia.
h. General appearance of claws under higher power of microscope.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Stated Meeting, January 20, 1888.

Present, 24 members.

Vice-President, Dr. RUSCHENBERGER, in the Chair.

Correspondence was submitted as follows, viz.: A letter from Col. R. Somers Hayes, New York City, N. Y., acknowledging his election to membership.

A letter from Dr. Aristides Brezina, Vienna, acknowledging receipt of his diploma and of Proceedings, Nos. 121, 122, 123, 124, and 125.

Acknowledgments for Proceedings, No. 125, from the Observatory at Tashkend, Russia; Zoölogical Society, Amsterdam; R. Accademia dei Lincei and Prof. G. Sergi, Rome; Essex Institute, Salem, Mass.; Profs. L. M. Haupt, John M. Maisch, James Tyson, Joseph Leidy, G. I. Riché, and Messrs. F. Graff, Philadelphia, and the University of Michigan, Ann Arbor; Colorado Scientific Society, Denver.

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A letter of envoy from the Bureau of Ethnology, Washington, D. C.

Accessions to the library were received from the Minister of Mines, Wellington; Mining Department, Melbourne; Gesellschaft für Anthropologie, etc., Messrs. Friedländer & Son, Berlin; Geographische Gesellschaft, München; Publishers of "Der Naturforscher," Tübingen; Prof. E. Renevier, Lausanne; Institution Ethnographique, Société de Geographie, Mon. Victor Duruy, Paris; R. Academia de la Historia, Madrid; Sociedade de Geographia de Lisboa; Society of Arts, London; Royal Geographical Society of Ireland, Dublin; Mr. A. F. Chamberlain, Toronto; Historical Society, New York; Franklin Institute, Mr. Henry Phillips, Jr., Dr. Ruschenberger, Philadelphia; Second Geological Survey of Penna., Harrisburg; Johns Hopkins University, Baltimore; U. S. Geological Survey, Bureau of Education, U. S. National Museum, Bureau of Ethnology, Hydrographic Office, Mr. C. F. Neill, Washington, D.C.; Prof.

C. L. Herrick, Granville, O.; Kansas Academy of Science, Topeka; University of California, Sacramento.

A photograph was presented for the Society's album by Dr. Aristides Brezina, Vienna.

A letter was read from the University of Bologna, inviting the Society to be represented at its ensuing eight hundredth anniversary, and on motion the President was authorized to appoint at his leisure a suitable person or persons for that purpose. (Subsequently the President appointed Messrs. Giovanni Capellini, of Bologna, and Henry Phillips, Jr., of Philadelphia.)

A circular was read from the Elizabeth Thompson Science Fund announcing that its funds were available for scientific work, and that applications for the same should be sent to Dr. C. S. Minot, Boston, Mass.

A letter was read from Henry Uhlke, Washington, D. C., offering for $200 a portrait of the late Spencer F. Baird. On motion, the President was authorized to appoint a committee of three to examine into the matter referred to, and to report to the Society.

A letter was read from Miss Marie A. Brown, Boston, Mass., enclosing a memorial to Congress in reference to a proposed Viking Exhibition.

A letter was read from the Iowa State University, Iowa City, requesting the Proceedings of the Society, and, on motion, it was ordered to receive the same from No. 96 and the catalog of the Society's library.

A prospectus of the American Folk-lore Society was read, and, on motion, the Society subscribed to the journal.

An obituary notice of Ferdinand V. Hayden, by Prof. Lesley, was read by the Secretaries.

The stated business of the meeting was then taken up, and the election for Librarian being in order, Mr. Henry Phillips, Jr., was unanimously reëlected Librarian for the ensuing year.

On motion, the President was authorized to appoint at his leisure the Standing Committees of the Society, which he subsequently appointed, as follows:—

Finance.—Henry Winsor, J. Price Wetherill, William B. Rogers.

Hall.—J. Sergeant Price, William A. Ingham, Charles A. Oliver.

Publication.—Daniel G. Brinton, George H. Horn, Persifor Frazer, Samuel Wagner, Patterson Du Bois.

Library.—Edwin J. Houston, William V. McKean, William John Potts, Jesse Y. Burk, William H. Greene.

Prof. Cope presented the following papers for the Transactions:—

I. The characteristics of the Vertebrate Fauna of the Puerco Epoch of North America.

II. Lemurine Reversion in Human Dentition.

III. The Shoulder, Girdle and Limbs of the Eryops.

The President was authorized to appoint at his leisure the usual committees to examine these papers. (Profs. Heilprin, Ryder and Lewis were subsequently appointed.)

Nominations Nos. 1173, 1174, and 1175 were read.

And the Society was adjourned by the presiding member.

Stated Meeting, February 3, 1888.

Present, 14 members.

President, Mr. FRALEY, in the Chair.

Correspondence was submitted as follows:—

Envoys: From the Mining Department, Melbourne; Smithsonian Institution, Bureau of Ethnology, Washington, D. C.; Prof. Antonio Peñafiel, Mexico.

Acknowledgments: Harvard College, Cambridge, Mass. (Transactions [N. S.], Vols. I–XV, XVI, 1); State University of Iowa, Iowa City (Procs. 96–126, etc.); State Historical Society of Wisconsin, Madison (Catalogue, Parts 1–4, inclusive).

Acknowledgments for Proceedings, No. 126, were received from Mr. Horatio Hale, Clinton, Ontario; Sir John William Dawson, Montreal; Geological and Natural History Survey of Canada, Ottawa; Toronto University, Canadian Institute, Dr. Daniel Wilson, Toronto; Historical and Scientific Society,

Winnipeg; Society of Natural History, Portland; N. H. Historical Society, Concord; American Academy of Arts and Sciences, American Statistical Association, Boston Society of Natural History, State Library of Mass., Dr. Oliver W. Holmes, Hon. Robert C. Winthrop, Boston; Museum of Comparative Zoölogy, Profs. A. Agassiz, Joseph Lovering, Mr. Robert N. Toppan, Cambridge; Essex Institute, Salem; Free Public Library, New Bedford; Dr. Pliny Earle, Northampton; Brown University, Rhode Island Historical Society, Rhode Island Society for the Encouragement of Domestic Industry, Prof. Thos. Chase, Providence; Connecticut Historical Society, Hartford; Yale College Library, Profs. Elias Loomis, H. A. Newton, New Haven; Prof. James Hall, Albany; Prof. W. LeConte Stevens, Brooklyn; Society of Natural Sciences, Buffalo; Prof. B. G. Wilder, Ithaca; Astor Library, New York Academy of Medicine, New York Academy of Sciences, New York Historical Society, New York Hospital, University of the City of New York, Drs. J. S. Newberry, J. J. Stevenson, J. A. Allen, Mr. John Ericsson, New York City; Vassar Brothers' Institute, Poughkeepsie; U. S. Military Academy, West Point; Prof. H. M. Baird, Yonkers; Rev. J. F. Garrison, Camden; Prof. George H. Cook, New Brunswick; Prof. W. H. Green, Princeton; Dr. C. B. Dudley, Altoona; Dr. R. H. Alison, Ardmore; Rev. J. A. Murray, Carlisle; Prof. Martin H. Boyé, Coopersburg; Profs. Traill Green, T. C. Porter, Easton; Mr. Andrew S. McCreath, Harrisburg; Profs. L. B. Hall, Isaac Sharpless, J. C. Booth, Haverford; Mr. John Fulton, Johnstown; Linnean Society, Lancaster; Messrs. P. W. Sheafer, Heber S. Thompson, Pottsville; Philosophical Society, Messrs. Edwin A. Barber, William Butler, Philip P. Sharples, Washington Townsend, West Chester; Wyoming Historical and Geological Society, Wilkes-Barre; The Athenæum, College of Physicians, Franklin Institute, Library Company of Philadelphia, Numismatic and Antiquarian Society, University of Pennsylvania, Wagner Free Institute, Zoölogical Society, Messrs. George W. Anderson, John Ashhurst, Jr., Cadwalader Biddle, George D. Boardman, J. H. Brinton, Isaac Burk, Thomas M. Cleeman, Patterson DuBois,

F. A. Genth, Jr., Frederick Graff, George Harding, Henry Hartshorne, H. V. Hilprecht, Edwin J. Houston, William A. Ingham, Francis Jordan, Jr., W. W. Keene, Joseph Leidy, F. W. Lewis, H. Carvil Lewis, John M. Maisch, E. Y. McCauley, F. A. Muhlenberg, Isaac Norris, Jr., Charles A. Oliver, C. Stuart Patterson, Robert Patterson, Henry Phillips, Jr., Franklin Platt, Theo. D. Rand, George J. Riché, Geo. B. Roberts, W. S. W. Ruschenberger, Oswald Seidensticker, Coleman Sellers, Aubrey H. Smith, George Stuart, W. P. Tatham, H. C. Trumbull, James Tyson, William H. Wahl, Henry Winsor, Henry D. Wireman, Ellis Yarnall, Joseph Zentmayer, Philadelphia; Wm. H. Canby, Wilmington, Del.; U. S. Naval Institute, Annapolis; Maryland Historical Society, Maryland Institute, Prof. Ira Remsen, Baltimore; U. S. Geological Survey, Patent Office, U.S. Naval Observatory, Surgeon-General's Office, Library of Congress, Signal Office, Messrs. J. H. C. Coffin, Thos. J. Lee, Wm. Ludlow, Garrick Mallery, Chas. A. Schott, William Strong, Wm. B. Taylor, Washington, D. C.; Virginia Historical Society, Richmond; Library of the University of Virginia, Prof. John W. Mallett, University of Virginia; Elliott Society of Science and Art, Charleston; University of South Carolina, Columbia; Georgia Historical Society, Savannah; Cincinnati Society of Natural History, Cincinnati Observatory; Dr. Leo Lesquereux, Columbus; Rev. Henry S. Osborn, Oxford, O.; Dr. Robert Peter, Lexington, Ky.; Prof. Daniel Kirkwood, Bloomington; University of Illinois, Champaign; Rantoul Literary Society; University of Michigan, Profs. Henry S. Frieze, Alex. Winchell, Ann Arbor; Davenport Academy of Natural Sciences; State Historical Society of Wisconsin, Madison; Colorado Scientific Society, Denver; University of California, Prof. John L. LeConte, Berkeley.

Accessions to the Library were announced from the Mining Department, Melbourne; Physiologische Gesellschaft, Deutsche Geologische Gesellschaft, Berlin; Académie R. des Sciences, etc., de Belgique, Bruxelles; Biblioteca N. Centrale di Firenze; Dr. Giulio Carotti, Milan; Société de Borda, Dax; Royal In-

stitution, Geological Society, London; Natural History Society of Montreal; American Chemical Society, Rev. Josiah Strong, Publishers of the "Critic," New York; Rev. S. F. Hotchkin, Dr. D. G. Brinton, Messrs. John H. and Edward B. Harden, Henry Phillips, Jr., Publishers of "The American Naturalist," Philadelphia; Mr. Ira Remsen, Baltimore; Bureau of Ethnology, Department of State, Signal Office, U. S. Fish Commission, Washington; Hon. Henry R. Jackson, Atlanta, Ga.; Rev. S. D. Peet, Mendon, Ill.; Davenport Academy of Sciences; Iowa State Historical Society, Iowa City; State Historical Society of Wisconsin, Madison; Prof. Antonio Peñafiel, Mexico.

The death of Prof. Asa Gray was announced as having taken place at Cambridge, Mass., on January 30, 1888, in the 78th year of his age.

Dr. Horn exhibited seven species of *Pleocoma* from California, of which three were new, and made some remarks on Dr. Gœrstecker's criticisms on the late Dr. LeConte's views of their position. These views Dr. Horn supported and insisted that the beetle was *Laparostict Lamellicon* and not a *Pleurostict*, as asserted by Dr. Gœrstecker. Dr. Horn exhibited some dissections in confirmation of his position.

Pending nominations Nos. 1173, 1174, and 1175 were read.

Mr. Garrett, from the Committee on the Purchase of the Humboldt Portrait, reported that the sum required for its purchase, $350, had been subscribed by the members of the Society.

The President reported that he had received and paid over to the Treasurer, $132.43, the quarterly interest of the Michaux legacy due January 1, 1888.

On motion of Mr. McKean, it was resolved that prior to the next appropriation of the Michaux legacy, the subject of the proper disposition to be made of it shall be considered by the Board of Officers and Council.

And the Society was adjourned by the President.

Stated Meeting, February 17, 1888.

Present, 19 members.

President, Mr. FRALEY, in the chair.

Correspondence was submitted as follows: A letter acknowledging diploma from Dr. Edward Suess, Vienna.

Acknowledgments for Proceedings from Fondation de P. Teyler, Harlem (125); Brooklyn Entomological Society (125, 126); Philadelphia Library Co., Mr. Thomas Meehan, Philadelphia (126); Mr. John F. Carll, Pleasantville, Pa. (126); Lackawanna Institute of History and Science, Scranton (126); Kansas Historical Society, Topeka (126); Prof. Joseph LeConte Berkely, Cal. (126).

Request for exchanges from the Naturwissenschaftlicher Verein des Regierungs-Bezirks, Frankfurt a O.; which, on motion, was granted from Proceedings, No. 96.

A circular from the U. S. National Museum, Washington, relating to "rude or unfinished implements of the paleolithic type," which was referred to the Curators.

Envoys from the Mining Department, Melbourne; Naturwissenschaftlicher Verein des Regierungs-Bezirks, Frankfurt a.O.; Bureau of Ethnology, Washington.

A photograph was received for the album from Mr. Heber S. Thompson, Pottsville.

Accessions to the Library were reported from Anthropologische Gesellschaft, Wien; Verein zur Beförderung des Gartenbaues in den K. P. Staaten, K. P. Landesanstalt und Bergakademie, Berlin; Naturwissenschaftlicher Verein des Regierungs-Bezirks, Frankfurt a.O.; Verein für Erdkunde, Halle a.S.; Verein für Erdkunde, Metz; R. Società Italiana D'Igiene, Milano; R. Accademia dei Lincei, Roma; R. Academia de Ciencias Naturales y Artes, Barcelona; Mr. Horatio Hale, Clinton, Canada; Massachusetts Historical Society, Boston; Museum of Comparative Zoölogy, Harvard College Observatory, Cambridge; Astor Library, New York; American Pharmaceutical Association, College of Physicians,

Inspectors of the State Penitentiary, Mr. Henry Phillips, Jr., Philadelphia; Interstate Commerce Commission, Washington, D.C.; Cincinnati Observatory, Society of Natural History, Cincinnati; Elliott Society of Science and Art, Charleston; University of California, Berkeley; Observatorio Nacional Argentino, Buenos Ares.

The Committee appointed to examine the papers presented for the Transactions by Prof. Cope, reported progress and was continued.

The President announced the decease of Sir Henry Sumner Maine (February 3, 1888, æt. 69).

The minutes of the Board of Officers and Council were submitted.

This being the stated evening for balloting for candidates for membership, pending nominations Nos. 1173, 1174, and 1175 were read, spoken to and balloted for.

New nomination No. 1176 was read.

Prof. Cope presented, through the Secretaries, for the Proceedings two papers: 1. On the Dicotylinæ of the John Day Miocene of North America. 2. Mechanical origin of the Dentition of the Amblypoda.

The following resolution was unanimously adopted:

"*Resolved*, That the President and Treasurer be authorized to sell, not exceeding $10,000 of the Loan of the City of Philadelphia standing in the name of the Society, and the Treasurer, J. Sergeant Price, be authorized to make the necessary transfer of the same upon the books of the City."

The recommendation of Council, that the Society should procure a fire-proof for the purpose of preserving its more valuable business and literary MSS. was, on motion, referred to the Committee on Hall to consider and report thereon to the Society.

The tellers reported after a scrutiny of the ballots that the following candidates had been duly elected members of the Society:

No. 2148, Charles E. Sajous, M.D., Philadelphia.

No. 2149. Alexander Biddle, Philadelphia.

No. 2150. Edmund B. Wilson, Bryn Mawr.

And the Society was adjourned by the President.

Stated Meeting, March 2, 1888.

Present, 13 members.

President FRALEY in the Chair.

Correspondence was submitted as follows: Letters accepting membership from Mr. Alexander Biddle, Philadelphia; Prof. Edmund B. Wilson, Bryn Mawr.

A letter offering resignation from membership, from Gen. Russell Thayer, Philadelphia. On motion the resignation was accepted.

A letter from the Society of Naturalists, Kieff, Russia, requesting exchanges, which was so ordered (96–127).

The President presented a letter from the Park Engineer in reference to an annual appropriation for the *Michaux* grove, which on motion was referred to Council.

The Newberry Library of Chicago was placed on the Exchange List to receive Proceedings from No. 96.

Letters of envoy from Société Impériale Russe de Géographie, St. Petersburg; Boston Society of Natural History, Museum of Comparative Zoölogy, Cambridge, Mass.

Letters of acknowledgment from Académie R. Danoise des Sciences et des Lettres, Copenhagen (124, 125); Geological and Natural History Survey, Ottawa, Canada (126); Boston Society of Natural History (123, 124, 125, 126); Boston Public Library (125, 126); Brown University, Providence (126); Academy of Sciences, St. Louis (126).

Accessions to the Library were received from the Royal Society of New South Wales, Sydney; Geological Survey of India, Calcutta; Société Impériale Russe de Géographie, St. Petersburg; Dr. L. Samenhof, Warsaw; Académie Royale de Copenhague, Société R. des Antiquaires du Nord, Copenhague; Société R. des Sciences de Liège; Prof. Antonio Favaro, Biblioteca N. Centrale, Firenze; R. Istituto Lombardo di Scienze Lettere, Milan; École des Mines, Paris; Commissão dos Tra-

balhos Geologecos de Portugal, Lisboa; Society of Antiquaries, London; Boston Society of Natural History; Museum of Comparative Zoölogy, Harvard University, Cambridge; Providence Franklin Society; Mr. Charles J. Hoadly, Hartford; Industrial Education Association, Dr. J. S. Newberry, New York; Mercantile Library, Commissioners for the Erection of the Public Buildings, Messrs. Thomas Hockley, Henry Phillips, Jr., Philadelphia; Johns Hopkins University, Editor of the "American Journal of Philology," Baltimore; Adjutant General's Office, D. C.; Mrs. L. M. Morehead, Cincinnati; The Newberry Library, Chicago; Lick Observatory, Sacramento; California Historical Society, San Francisco.

The special committee appointed January 20th, to examine the papers of Prof. Cope, reported in favor of publishing those on the Eryops and the Puerco Fauna; on that on Lemurine Reversion it did not report favorably.

Prof. T. B. Stowell presented through the Secretaries papers on the Hypoglossal nerve, the Accessory nerve, and Glossopharyngeal nerve of the domestic cat.

Mr. Frank Jordan, Jr., presented through the Secretaries a paper on The Aboriginal Pottery of the Middle Atlantic States.

Pending nomination No. 1176 was read.

Mr. Philip C. Garrett, chairman of the committee appointed by the Society to procure for it the portrait of Baron von Humboldt, painted from life at Berlin in 1856, by Mr. J. R. Lambdin, at the request of Messrs. Henry D. Gilpin and Alexander Dallas Bache, reported that it had been purchased for $350, and on behalf of the following gentlemen who had contributed for that purpose, formally presented it to the Society: Messrs. G. W. Anderson, John R. Baker, R. Meade Bache, George H. Boker, W. G. A. Bonwill, Geo. W. Childs, E. W. Clark, J. M. Da Costa, Frederick Fraley, Philip C. Garrett, Horace Jayne, E. Otis Kendall, Wm. V. McKean, J. Sergeant Price, James W. Robins, Moncure Robinson, J. R. Shipley, Wm. P. Tatham, Frank Thomson, Richard Vaux, Joseph Wharton, Henry Winsor and Richard Wood.

Mr. Garrett in presenting the portrait made the following remarks:

"About the year 1856, while Mr. Alexander Dallas Bache was sitting to Mr. Lambdin for his portrait, the latter suggested a plan by which the Smithsonian Institution could materially aid schools in this country in procuring copies of the best foreign works of art. Having received the approval of the Board of Regents, Mr. Bache furnished Mr. Lambdin, who was about to visit Europe, with credentials from the Smithsonian to various eminent persons abroad, among others to Baron von Humboldt. It occurred to Mr. Bache *apropos* of the latter, that it would afford the artist a capital opportunity to obtain a portrait of Humboldt, which he would like to have for the American Philosophical Society, and Mr. Gilpin joining him in the purpose, they authorized Mr. Lambdin to paint a portrait of the *savant*, agreeing to see it presented to the Society upon its completion. Mr. Lambdin had an excellent opportunity with the Baron, with whom he spent the larger part of a day, on his arrival in Berlin. Humboldt was at that time the King's Chamberlain, and said that he would shortly have to go to Potsdam to attend the King, but would give Mr. Lambdin further sittings on his return to Berlin. He was then 87 years old, a little man, very much bent, extremely courteous, and was much pleased that his portrait was wanted for the American Philosophical Society, expressing gratitude to his friend Mr. *Bash* (Bache) that he had thought of it.

"The result is before the Society in an admirable and speaking likeness, and, to my mind, no more appropriate portrait adorns the walls of a Society whose scope is so philosophical and broad as that of this learned body.

"A terse and comprehensive description of the renowned philosopher is found in the following paragraph from the Edinburgh Review of 1848:

"'Science has produced no man of more rich and varied attainments, more versatile in genius, more indefatigable in application to all kinds of learning, more energetic in action, or more ardent in inquiry.'

"The same Review describes him as possessing 'a genial and kindly temperament, which excites no enmities, but, on the contrary, finds or makes friends everywhere. No man in the ranks of Science is more distinguished for this last characteristic than A. v. Humboldt. We believe that he has not an enemy.'

"It only remains for me formally to present the picture on behalf of the donors, whose names follow, and this I have great pleasure in doing. I should add that the carrying out of the original intention was prevented by the illness of Messrs. Bache and Gilpin, before the completion of the work, followed by their death."

On motion the committee was discharged and the thanks of

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the Society were voted to its chairman for his zeal and interest.

The Report of the Trustees of the Building Fund was presented.

On motion the President was requested, authorized and empowered to send with letter referred to in the Resolution of the Society of January 6, 1888, a copy of the Reports of the special committee on the value of Volapük.

On motion the Committee on Volapük was continued and requested to report from time to time on any matter kindred to the subject that may reach its knowledge.

And the Society was adjourned by the President.

Stated Meeting, March 16, 1888.

Present, 15 members.

Mr. RICHARD VAUX in the Chair.

Miss Helen C. de S. Abbott, a lately elected member, was presented to the Chair and took her seat.

Correspondence was submitted as follows:

A letter from Dr. C. E. Sajous, Philadelphia, accepting membership in the Society.

Letters of envoy from the K. Preuss. Meteorolog. Institut and K. Geolog. Landesanstalt und Bergakademie, Berlin.

Letters of acknowledgment for Proceedings, No. 125, from the Gesellschaft für Erdkunde, Deutsche Geologische Gesellschaft, Berlin; K. Sächsischer Alterthumsverein, Dresden; Oberhessiche Gesellschaft für Natur- und Heilkunde, Giessen; Naturhistorische Gesellschaft, Hanover; Dr. Otto Böhtlingk, Leipzig; Prof. Dr. Dümichen, Strasburg; H. C. de S. Abbott, Philadelphia; Dr. Jesus Sanchez, Mexico.

For Proceedings, No. 126, from the Société Géologique de France, M. Victor Duruy, Prof. Abel Hovelacque, Paris; R. Meteorological and Astronomical Societies, Board of Trade,

Geological Society, Victoria Institute, Society of Antiquaries Mr. Archibald Geikie, London; H. C. de S. Abbott, Philadelphia.

A communication from Dr. W. C. Winslow, in reference to the Egyptian Exploration Fund, was read.

Accessions to the Library were reported from Dr. Otto Donner, Helsingfors; Hungarian Academy, Buda Pesth; K. K. Zoologisch-Botanische Gesellschaft, K. K. Geologische Reichsanstalt, Wien; Naturforschende Gesellschaft, Bamberg; K. P. Geologische Landesanstalt und Bergakademie, K. P. Meteorologisches Institut, Berlin; Oberlausitzische Gesellschaft, Görlitz; Deutsche Gesellschaft für Anthropologie, etc., Baron E. de Selys Lonchamps, Liége; Société de Geographie, Paris; Instituto y Observatorio de Marina, San Fernando; Philosophical and Philological Societies, Prof. Joseph Prestwich, London; Dr. George M. Dawson, Montreal; Publishers of the "New England Magazine," Boston; American Antiquarian Society, Worcester; New York State Museum of Natural History, Albany; Publishers of "The Brooklyn Medical Journal;" Dr. Persifor Frazer, Mr. Henry Phillips, Jr., Philadelphia; Signal Office, Smithsonian Institution, Washington.

Dr. Frazer made the following oral communication:

In a recent visit to the eastern portion of Cuba under exceptionally favorable circumstances, I was enabled to obtain some interesting data on the geology of this part of the island which I believe to be new and important, and which when put into form will constitute a paper on these subjects. As my work on this paper is not complete, I do not intend to dwell upon any part of it to-night, further than to say that the area which I was enabled to examine included portions of the Sierra Mæstra range and its foot hills between Guantanamo and Santiago de Cuba; ten miles north of that city and in the neighborhood of Christo on the Enramados R. R.; and south-west of Santiago in the hills surrounding the pretty village of El Cobre. The many mines of iron, manganese and copper, and the localities where deposits of these metals were indicated, were not, however, the only interesting features to the geologist. The rocks themselves told an important tale of the age of this part of the world. Outside of an official but not exhaustive examination of this region by Señor Castro, and examinations for special purposes by Messrs. Graham, Dr. J. P. Kimball and others, no serious study of its measures has been made.

It will sufficiently indicate the importance of such a general examination when it is said that there is a strong probability of the occurrence here of a large part of the Archean rocks which lie between the Lower Laurentian and the Paleozoic, and that the metalliferous deposits which are of undoubted value take their places in a manner analogous to similar deposits in the United States and elsewhere.

It is not intended in these few hasty remarks to present any of the peculiarities of vegetation, climate and customs to the members of this Society as if these were items of news which many of them had not observed for themselves, but simply to note a few impressions which may be new to some of his hearers as they were to the speaker.

Along with the luxuriance of the vegetation, the circumstance which struck the speaker with most astonishment was the paucity of small animals and reptiles and birds in the forests. Ants and their mounds are observed everywhere, and small lizards are not uncommon, but snakes and toads and field-mice, etc., etc., were conspicuous by their absence.

During a sojourn of some weeks only one Maha, a black snake some two and a half feet in length, was seen in our journeys and camps through the forests and over the hills and mountains. The average temperature during the day, in the shade, was 81° to 86° Fah. (during the month of January), and at night this fell to 71° to 75°. There were occasional showers of rain, but as a general rule the weather was delightfully bright and calm. The temperature of a mountain stream, taken about 2000 feet above the sea at sunset, was 75° Fah.

[Numerous specimens of coral, modern shells, cocoanuts, bamboo, etc., were exhibited, as well as two drinking cups such as are fashioned by the mountaineers out of the bamboo by cutting a segment and slicing off the rim in a bevel to form a lip.]

Miss Helen C. de S. Abbott made the following remarks on the Occurrence of a Series of New Crystalline Compounds in Higher Plants:

"In many plants, especially those which belong to the natural orders, Simarubaceæ, Polemoniaceæ, Rubiaceæ, Ebenaceæ, Rhodoraceæ, and Compositæ occur, respectively, a class of compounds which present definite crystalline forms. They are extracted from the plants most readily by a light petroleum ether. Boiling absolute alcohol was used to purify these compounds from fats, wax, and coloring matter, and by fractional crystallization three distinct forms of crystals were obtained which on ultimate analyses represented compounds of different chemical constitution.

"These bodies are characterized by containing a high percentage of carbon. They are indifferent to alkalies and have high melting points. The discovery of one of these compounds in Cascara Amarga was made by me in 1884, and announced at the Buffalo meeting of the American

Association for the Advancement of Science. Since that time my investigations are continuing and, from these studies, I am able to announce, as derived from plant sources, compounds which until now have not been observed.

"Lately, from independent investigations, Prof. Henry Trimble has also discovered similar compounds in various plants. Our mutual results will form the substance of a future communication."

Mr. Henry Phillips, Jr., presented a *First Contribution* to the Folk-lore of Philadelphia and its vicinity.

Dr. Oscar Meyer presented (through the Secretaries) a paper on the Miocene Invertebrates from Virginia.

Pending nomination, No. 1176, and new nomination, No. 1177, were read.

Mr. Phillips, from the Committee on Volapük, reported on the Langue Internationale of Dr. Samenhof, of Moscow, and the Committee was continued.

And the Society was adjourned by the presiding member.

Stated Meeting, April 6, 1888.

Present, 14 members.

President, Mr. FRALEY, in the Chair.

Correspondence was submitted as follows:

A letter of acceptance of membership from Prof. Giuseppi Meneghini, Pisa.

Letters requesting exchanges, from the Royal Mint, Melbourne, Australia; Elisha Mitchell Scientific Society, Chapel Hill, N. C., and on motion the requests were granted.

Letters of envoy from K. Sächsische Gesellschaft der Wissenschaften, Leipzig; Gesellschaft zur Beförderung der Gesammten Naturwissenschaften in Marburg; Université Royale de Lund; Meteorological Office, Royal Statistical Society, London.

Letters of acknowledgment from Royal Society of New

South Wales, Sydney (124, 125); Prof. Peter von Tunner, Leoben, Austria; Prof. I. I. S. Steenstrup, Copenhagen; Deutsche Geologische Gesellschaft, Gesellschaft für Erdkunde, Berlin; K. Sächsische Alterthumsverein, Dresden; Oberhessische Gesellschaft für Natur- und Heilkunde, Geissen; Naturhistorische Gesellschaft, Hanover; Dr. Otto Böhtlingk, Leipzig; Prof. Dr. J. Dümichen, Strasburg; Université Royale de Lund; Dr. Jesus Sanchez, Observatorio Astrónomico Nacional, Mexico (125); K. K. Central-Anstalt für Meteorologie und Erdmagnetismus, Wien; Naturwissenschaftlicher Verein zu Bremen; Verein für Thüringische Geschichte "Isis," Dresden; Dr. G. von Rath, Bonn; Dr. Julius Platzmann, Leipzig; K. Sternwarte, München; Dr. Otto Schumann, Tübingen; Natur-Histor. Museum, Strasburg; Societé de Borda, Dax, France; Sociétés D'Anthropologie, Geologique, M. Auguste Carlier, Hon. Victor Duruy, Profs. Abel Hovelacque, Remi Siméon, Paris; Prof. Lucien Adam, Rennes, France; Philosophical Society, University Library, Rev. S. S. Lewis, Cambridge, Eng.; Royal Society, Royal Institution, Royal Astronomical, Meteorological Societies, Society of Antiquaries, Geological Society, Board of Trade, Victoria Institute, M. Archibald Geikie, Sir Richard Owen, Prof. C. Schorlemmer, Manchester; Natural History Society, New Castle-on-Tyne; Dr. Henry W. Acland, Oxford; Dr. James Geikie, Edinburgh; Prof. C. H. Hitchcock, Hanover, N. H. (126); Physiologische Gesellschaft, Berlin (96–126, etc.).

Accessions to the Library from the Linnean Society of New South Wales, Sydney; Geological Survey of India, Calcutta; Royal Asiatic Society, North China Branch, Shanghai; K. Akademie der Wissenschaften, St. Petersburg; Societé Impériale des Naturalistes de Moscow; K. K. Geographische Gesellschaft in Wien; Naturwissenschaftliche Gesellschaft "Isis," Dresden; K. Sächsische Gesellschaft, Leipzig; Gesellschaft zur Beförderung der Gesammten Naturwissenschaften, Marburg; K. Statistische Landes-Anstalt, Stuttgart; University of Lund, Sweden; Academie Royale de Belgique, Bruxelles; Société Americaine de France, "Cosmos," Paris; Prof.

Joseph Prestwich, Shoreham, Eng.; Bath and West of England Agricultural Society, Bath; Royal Statistical Society, Meteorological Council, "Nature," London; Prof. Eben Norton Horsford, New York; Mr. W. J. Potts, Camden; Academy of Natural Sciences, Historical Society of Pennsylvania, Messrs. Henry Phillips, Jr., Richard Wood, Philadelphia; Elisha Mitchell Scientific Society, Raleigh, N. C.

A photograph for the album was received from Dr. Julius Platzmann, Leipzig.

The following deaths of members were reported:

F. Bowyer Miller, Melbourne, September 17, 1887.

James Curtis Booth, Philadelphia, March 21, 1888, æt. 78.

Joseph Zentmayer, Philadelphia, March 28, 1888, æt. 62.

On motion, the President was authorized to appoint suitable persons to prepare the usual obituary notices for Messrs. Booth and Zentmayer.

Mr. Law presented, for the Proceedings, a paper on "Gildas and Early English History."

Mr. DuBois, from the Committee on Revised Spelling, appointed January 6, 1888, reported progress, and the committee was continued until it should be ready to make a final report.

Prof. Edwin J. Houston made the following oral communications:

On Death by the Electric Current.

Several cases of death have resulted from incautious or accidental touching or handling of the wires employed in carrying the currents used in electric lighting. It becomes, therefore, a matter of great importance to inquire into some of the peculiarities of such accidents.

There are, as is well known, two distinct characters of current employed for the purpose of electric illumination; viz., the direct current and the alternating current. The direct current, as employed in electric lighting, is fairly steady and uniform. Its electro-motive force, as a rule, is not subject to marked changes in value, and the direction of its flow is always the same. The alternating current, on the contrary, changes both the value of its electro-motive force and its direction, taking its name from the fact that it flows alternately in opposite directions. The changes in the electro-motive force are considerable in amount; they are not, however, as is very generally believed, necessarily sudden, since in most cases the

electro-motive force changes gradually from a maximum to a minimum in both directions.

Death has resulted from the incautious handling or accidental contact both with the direct and with the alternating current.

In the case of the direct current, death results sometimes from shock, but generally, it would appear, from an electrolytic effect on the blood or other tissues of the body. The gaseous products arising from the decomposition possibly may, in some cases, be carried by the blood to the heart and thus stop its action, or, as probably occurs in most cases, death may result from electrolytic changes produced in the blood itself, or in other tissues.

Death by the alternating current probably results from shock only. Resuscitation in cases of apparent death are more frequent with the alternating current than with the direct, most probably from the absence of actual electrolytic decomposition of the tissues.

Considerable surprise has often been manifested because certain currents, that, in some instances, have been handled with impunity, in other cases have caused death. A current of a certain number of ampères, and of a certain difference of potential between the points touched, caused death in one case, while in another case with the same current strength in the line, two or three times the difference of potential between the points touched, was received with impunity.

Making due allowance for differences in vitality, or in the condition of the heart-power of the subject, I think the following explanation will throw light on many of these cases. I offer it, however, mainly, though not entirely, from a theoretical standpoint.

The explanation would appear to be found in the portions of the body at which the current enters and passes out, which would of course necessarily be influenced by the position of the person receiving the discharge. Nearly all fatal or severe shocks occur from the lines being accidentally grounded at some point. The person then either deliberately touches, or is accidentally brought into contact with the line at some other point. Under these conditions, the electricity either passes into or out of the body at the feet. The greater or less probability of serious results will depend on the parts of the body through which the current passes. When any part of the body is placed in the path of an electric discharge, more of the discharge will pass through the better conductors, which perhaps will, generally, be the great nerve trunks and the muscles. Reference must, therefore, be had to the position of such nerve centres, as well as to the heart, the lungs and the viscera and other vital organs. The following contacts are among the commonest.

(1) At the head. This contact is apt to be among the most dangerous, as the discharge in all probability takes place through some of the vital organs, such as the brain, the upper part of the spinal cord, or through some of the organs in the abdominal cavity, or their principal nerves.

(2) At the shoulders. This is probably somewhat less dangerous than

the preceding, as the brain is not in the path of the direct discharge. The vicinity of the upper part of the spinal cord is, however, very dangerous.

(3) At one of the hands. If the person is standing on both feet, this may be fatal, since the organs of the abdominal cavity and its nerve centres are in the path of the discharge. If the person is standing on one foot, then if this foot be on the same side of the body as the hand that is touched, the discharge will probably not be fatal, since the discharge does not necessarily pass through the organs of the abdominal cavity. If, however, the foot on which the person is standing be on the other side of the body from the hand that touches the wire, that is if the person be standing on the right foot and touches the wire with his left hand, the discharge, if powerful, is apt to be fatal, since the organs of the abdominal cavity and its nerves are necessarily in the path of the discharge.

(4) On the back, especially in the upper portion. This is apt to be fatal, since the spinal cord is dangerously near the path of the discharge. The muscles of the back are also very large and would thus determine the passage of much of the current in this direction.

(5) Discharges ensuing on touching the wires with each hand are apt to be fatal, since the heart lies in the path of the current.

Those exposed to electric discharges would be protected from the effects of accidental grounding of the conductors, by wearing plates or discs of any high insulating material on the soles of the shoes, or inside the same.

Death by lightning probably results from the effects of shock, combined with those of electrolysis. In discharges of such enormous difference of potential as exist in lightning, disruptive effects may also be produced.

The almost instantaneous and consequently painless nature of death by the electric shock has, as is well known, led to the suggestion that it be employed in public executions in place of hanging or decapitation. Should such suggestion be adopted, the character of the apparatus employed should be such as to cause death by shock, followed, to avoid the possibility of resuscitation, in case of apparent death, by the passage of an electrolyzing current.

On the Paillard Palladium Alloys in Watches.

I have concluded my experiments on the Paillard watches. The following results were reached; viz.,

I am satisfied that a watch whose balance-wheel, hair spring, and escapement are made of the Paillard palladium alloys can not have its rate sensibly affected by the influence of any magnetic field into which it is possible to bring it while on the person of its wearer.

In order to test this, such watches were carried into exceedingly powerful magnetic fields, and although carefully rated, both before and after exposure, no sensible change in their rate could be detected.

Experiments showed that the palladium alloys are entirely destitute of any paramagnetic properties. As far as the amount of the alloys at my

disposal permitted, experiments failed to show that they possessed any diamagnetic properties.

A number of these alloys are made by Mr. Paillard. The composition of four described by him in his U. S. patents, and numbered for convenience Nos. 1, 2, 3, 4, is as follows, viz:

Palladium Alloy No. 1.

Palladium	60 to 75 parts.
Copper	15 to 25 "
Iron	1 to 5 "

Palladium Alloy No. 2.

Palladium	50 to 75 parts.
Copper	20 to 30 "
Iron	5 to 20 "

Palladium Alloy No. 3.

Palladium	65 to 75 parts.
Copper	15 to 25 "
Nickel	1 to 5 "
Gold	1 to 2½ "
Platinum	½ to 2 "
Silver	3 to 10 "
Steel	1 to 5 "

Palladium Alloy No. 4.

Palladium	45 to 50 parts.
Silver	20 to 25 "
Copper	15 to 25 "
Gold	2 to 5 "
Platinum	2 to 5 "
Nickel	2 to 5 "
Steel	2 to 5 "

The complete masking of the paramagnetic properties of some of the ingredients of these alloys is of considerable interest, and would seem to indicate a true chemical union of their constituents. The most interesting results of my experiments, however, were those in which it was established that no matter of what materials the balance wheel or hair spring may be made, provided they are conductors of electricity, their movements through a magnetic field, when the moving masses properly cut the lines of force, must result in a change in their rate of movement, and consequently in a change in the rate of the watch; or, briefly, it was established that *a watch placed in a magnetic field acts like a dynamo-electric machine.*

The amount of this action is exceedingly small. In order to detect it, a very powerful magnetic field must be employed, and the watch subjected to its influence for an hour or more.

In order to obtain this field, and to properly concentrate it on the rim of the balance wheel (thus placing said rim in a position analogous to the copper disc in the well-known experiment between the poles of an electro-magnet), I mounted massive conical pole pieces, of soft iron, inside the pole pieces of the armature field of an Excelsior arc-light machine, whose armature had been removed. The space left between the opposing ends of these pole pieces was just sufficient to permit the introduction of the watch.

The watch was then securely fixed in place, with its face upwards, so that the lines of magnetic force, concentrated on that part of the edge of the balance wheel nearest the edge of the watch, passed through it at right angles to the plane of its movements. After an exposure of one hour to the influence of this extraordinary field, *the watch was found to have gained fifteen seconds.*

I believe that the cause of the gain is to be ascribed to a decrease in the arc of oscillation of the balance wheel, which would thus result in an increase in the rapidity of its movements.

The fact that the watch, after its removal from this powerful field, did not manifest any sensible change in its rate, shows the extent of the protection the palladium alloys give it against the effects of external magnetism.

The Committee on Volapük reported that it had considered the communications from Prof. P. Steiner, of Darmstadt, in reference to the claims of *Pasilengua* for adoption as a universal language, and those of Prof. G. Bauer, of Agram, in reference to his improved Volapük, entitled *Speling*, and offered the following resolution for the consideration of the Society.

The Society having considered the communications from Dr. Steiner in reference to *Pasilengua*, and Dr. Bauer in reference to *Speling*, in view of its resolution of January 6, 1888, proposing a Congress to consider the project of an International Scientific Language, while recognizing the full value of Dr. Steiner's labors and the changes made by Dr. Bauer, must decline to commit itself in advance of any action by such Congress to any individual scheme, however meritorious.

The resolution was, on motion of Mr. Vaux, unanimously adopted.

Pending nominations Nos. 1176 and 1177 and new nomination No. 1178 were read.

And the Society was adjourned by the President.

Observations on Gildas and the Uncertainties of Early English History.

By Philip H. Law.

(*Read before the American Philosophical Society, April 6, 1888.*)

Historians and antiquarians have been inclined to base their statements too much on guesses. Pyramids of very doubtful conjecture have been erected on a foundation of a very few facts: and those facts very uncertain. The pregnant aphorism of Dr. Johnson that history written from facts not recorded at or near the time of their happening is a mere work of the imagination, should be constantly present to their minds. But, alas, it is generally ignored, for if it were applied it would reduce the vast volumes of archæological learning to a very small compass.

Any one reading the early history of England in the popular historians and of its conquest by the so-called Anglo-Saxons, but who called themselves the Æglisk, would believe that our knowledge of the events of its conquest were certain; at least, as certain as the events of the reign of Edward I.

But if we examine the sources of information we will find them to be profoundly unreliable. That a conquest did occur, a severe and drastic one, cannot be doubted or denied. The great change of language establishes this; absolutely proving the obliteration or enslavement of the native population. The latter was, according to the probabilities, the case.

The captive of a rude and warlike people is too useful to be slain except in the heat of battle. The barbarian hates persistent work; his labor is war; his enjoyments are the chase and the wassail bowl; and land, without slaves to work it, is for him but of little use.

The historians of the Anglo-Saxon Conquest draw their facts from the monk Gildas. And to these the writers of the picturesque school, such as the late Mr. Green, add facts drawn from their imagination; for example, Mr. Green in his special history of the period describes, as if he was an eye-witness what is a matter of pure conjecture, giving a most vivid account of the sack of Anderida, the line of march taken by the different Saxon bands, how they fought, and what they did.

But as to these we have but one authority who has even pretensions to be a contemporary—Gildas, the British monk. A few casual but not connected remarks occur in Continental writers. Britain in the days of the Roman Empire was a very obscure and very unimportant dependency. It was not more important to the Roman Empire then than New Zealand is now to the present English Empire. Naturally, therefore, very little importance was attached to what happened there; indeed, the whole Latin literature of the time, except in theology, is scanty. The Anglo-Saxons were completely barbarous and without letters. No record was kept by them of their conquest. Gildas, therefore, is our only authority, and if his authenticity is disproved, complete darkness will cover the subject of

the Anglo-Saxon Conquest, except such inductions as we may form from change of language.

I will, therefore, examine the claims of Gildas. He is reputed to have been a Welsh monk who wrote about 520 A.D.; and his youth would have been nearly contemporaneous with the Saxon invasions. The book is in Latin and bears the title of "De Excidio Britanniæ;" and covers about fifty or sixty pages of a small duodecimo volume. It is composed of two parts, distinct in their nature; the first containing the history of the invasions; the second, a long, rambling account of remarkable events which occur in the Biblical narrative. The style is most singular. It is not a mere dry narrative of events like most of the so-called Chronicles, interspersed with naive and quaint remarks; but it has a distinct lyrical tone and manner, with a kind of rhythmical flow of the sentences; indeed, it reads like a prose chant. It commences with a description of the wickedness of the Britons, ascribing to them all manner of sins. After the departure of the Roman armies they fall into divisions and civil wars. The Picts attack them, and upon their doleful complaints to the Romans, the Romans return, drive out after many battles the Picts, and to secure them from further attacks, build the great wall. Upon their departure the Picts recommence their attacks. The Britons send again for the Romans, who, after conquering the Picts, build another and larger wall from sea to sea, protected by large castles erected upon it. But this does not prevent the Picts from entering and commencing fresh attacks, harrying and destroying the whole country. The Romans returning to their frantic appeals a deaf answer, Vortigern, one of their kings, calls in the Saxons, and here occurs the well-known tale of Vortigern and Rowena. The Saxons, from being merely auxiliaries, quickly take advantage of the weakness of their allies and proceed to subjugate them; and, being joined by numbers of their kinsfolk from across the sea, gradually conquer the whole of Britain.

This is the account found in almost all the English histories as the reliable account of the Saxon Conquest. Historians desirous of forming a connected account, naturally do not like to acknowledge ignorance of the most important event and revolution in the annals of the country; no less than a complete change in its language and probably a partial change in the blood of the people, certainly of that of the ruling class.

But to archæologists who require proof, Gildas has always appeared a most unhistorical writer and of no authenticity. Several facts which lie patent in his book have always struck them as entirely inconsistent with a contemporary author such as he claims to be; and first, his peculiar style, which is utterly unlike what a contemporary historian would use. It appears much more like a poem turned into prose than a dry narrative of facts. And second, from his notorious errors in history, in which he narrates as contemporaneous, events which had occurred long before; for instance, his describing the civil wars of Maxentius and Constantine as occurring about that time when they occurred nearly a cen-

tury before. And, above all, from his describing as then being built, the two great northern walls of defense, while we know that one of them had been built by Hadrian nearly three hundred years, and that the other, the wall of Severus, nearly two hundred years. These facts, in my opinion, are crucial tests. It is possible, perhaps, for a contemporary to be mistaken as to the civil wars, but how could it be possible to make such a mistake about a fact which was so patent as the building of those great walls?

As well could a person who pretended to live in A. D. 1888 in Philadelphia, assert that the great city hall was erected by William Penn.

Such a statement would stamp at once its author, whatever his pretensions might be, as not a contemporary.

Besides this many of the facts which we know from the Roman records and from the remains of the burials and other records, are inconsistent with the common story of the Saxon Conquest.

From the Notitia Imperii, which was a survey of the Roman Empire taken in the end of the fourth century, we learn that the whole of the east coast was already called the Litus Saxonicum, the Saxon Shore; and was governed by a special Count, thus probably indicating that a large population of that race was already there settled.

From the remains disinterred from the tombs it appears that the Saxons and Britons were frequently buried side by side, each corpse in the respective national manner.

Another remarkable fact also appears from the inspection of these tombs, that scarcely any appearance of Christian burial has been found. From this it would seem that most of the British population still remained Pagan; a fact which will perhaps explain why the Saxons did not, like the Franks, the Goths, the Allemanni, adopt Christianity.

The information furnished by the Welsh chroniclers seems always to have been particularly unreliable. They are full of inventions which are plainly the work of their own fancies. In Nennius, who is a Welsh writer on the history of Britain, and who cannot be later than the commencement of the tenth century at the farthest, the legend of King Brute and his Trojans already begins. This was finally developed in Geoffrey of Monmouth, a Welsh Bishop about 1150 A. D., who starting from King Brute develops a long line of Kings until the time of Julius Cæsar. He gives their names, the incidents of their reigns, their personal peculiarities and their speeches, with a detail and a certainty almost amazing. Frequently these contradict the well-known facts related in the Roman historians. The Roman history, though well known at the time from the manuals like Orosius and others which were extensively copied and read in the middle ages, does not seem to inspire him with any doubt. It has always struck me as a most singular historical problem why such fables and inventions could have been so readily accepted. They were given place in almost all the histories of England which were written until the time of the Renaissance, and were apparently accepted as completely credible, and indeed almost to the commencement of the seventeenth century.

Also they scarcely seem to have been the result of conscious invention. Geoffrey of Monmouth was apparently a man of good character and a Bishop of the church. His position, therefore, seems to render it improbable that he committed a complete literary forgery like that of George Psalmanazzar; and if he did not, what was the origin of these tales?

I conjecture, although I have very little proof to offer, that it may have originated something in this way. The Welsh chieftains were all fond of poetry, and kept in their service bards to sing their praises and that of their ancestors. Long genealogies were spun out connecting them with the great of the olden time. The license of song and verse would naturally increase the facility of invention.

This poetry would gradually in an uncritical age become considered veritable history, and finally, clipped of its ornaments, be turned into sober prose, and make its appearance as authentic history. An enormous mass of Welsh poetry is, I believe, in existence, mostly unprinted, and it would be very interesting and instructive if some scholar learned in Welsh, and with access to the manuscripts, would examine if the legendary history of Britain did not originate in this manner.

The same causes would explain the legendary history of Scotland, the darkness of which is incomparably greater than that of England. Indeed, it seems to me that with the exceptions of the glimpses afforded by the occasional notices of English chroniclers, nothing definite is known until about the time of Edward I of England.

A long series of kings is given with the events of their reigns, yet no explanation is given of the change from a Celtic-speaking people to an English-speaking people, apparently about the year 1000 A. D. The lowlands of Scotland were a people who used Gaelic and were governed by kings with characteristic Celtic names of Macbeth, MacDuff, Duncan, Malcolm, and with institutions of the regular clan or tribal nature. But when the light of history becomes bright and clear, they speak a dialect of English, their institutions are of the feudal rather than the clan type—their kings and nobles have names either Teutonic or Norman in the etymology; and yet of this great revolution there is not a word in history.

On Miocene Invertebrates from Virginia (With Plate).

By Otto Meyer, Ph.D.

(*Read before the American Philosophical Society, March 16, 1888.*)

Prof. J. J. Stevenson, of the University of New York, has collected a quantity of Miocene material near Yorktown, Va. In his collection there are quite a number of specimens of large species in fine preservation, like Mercenaria tridacnoides Lam. sp., Panopea reflexa Say, Ecphora

quadricostata Say sp., and others. He transmitted to me recently for examination some little shells and some sand adhering to some of these large shells, in which material the species enumerated below were found. Partly they are already known to occur in Yorktown, for their greater number, however, they are described from other localities of the Atlantic Miocene. A few forms are new or new to the American Tertiary.

Some of the determinations were made from the published descriptions and figures, but in many cases these are insufficient for a determination, especially as far as the smaller species are concerned. Therefore, frequently the type-specimens in the collection of the Academy of Natural Sciences were compared and especially the forms described by H. C. Lea, from Petersburg, Va.,* had to be studied. My thanks are due to the Curator in charge of the Academy, Prof. A. Heilprin, who enabled me to study a great number of fossil types. Besides, I am obliged to the Curator of Molluscs of the Academy, Mr. Geo. W. Tryon, Jr., who gave me the opportunity to compare recent material. †

It is here not attempted to give the ultimate names of all the enumerated species, for this would presuppose a nearly complete working up of the Atlantic Miocene palæontology, including a comparison with recent, Eocene and European forms. But the opportunity is used at least in some cases to unite species, which, in my opinion, are synonyms. The following list of smaller species from Yorktown, Va., will probably be increased considerably in future, as the quantity of examined sand was only a small one.

I. Species known from the Atlantic Miocene.

Lamellibranchiata.

Ostrea sp. (juv.)
Anomia Ruffini Conr.
Plicatula marginata Say.
Lima papyria Conr.
Pecten eboreus Conr.
Arca centenaria Say.
Arca carolinensis Conr.
Pectunculus lentiformis Conr.
Pectunculus subovatus Say.
Nucula diaphana H. C. Lea.
Leda acuta Conr.
(= Leda carinata H. C. Lea.)
Yoldia lævis Say sp.
Carditamera arata Conr.

* Transact. Amer. Philos. Soc., Vol. ix, pp. 229–274.

† Since the above was written, Science has lost a valuable worker in Mr. G. W. Tryon, Jr., whose death occurred on Feb. 5, 1888.

Venericardia granulata Say.
Venericardia tridentata Conr.
Astarte vicina Say.
Astarte undulata Say.
Crassatella undulata Say.
Gouldia lunulata Conr.
Chama congregata Conr.
Kellia lævis H. C. Lea sp.
Erycinella ovalis Conr.
Lepton mactroides Conr.
Diplodonta acclinis Conr.
Lucina crenulata Conr.
(= Lucina Leana d'Orb.)
(= Lucina lens H. C. Lea.)
Venus cortinaria Rogers.
Circe metastria Conr.
Tellina lusoria Say.
Tellina producta Conr.
Semele subovata Say sp.
Saxicava arctica Linné, var. bicristata Conr.*
Mactra modicella Conr.
Corbula cuneata Say.
(= Corbula inæqualis Say.)

Glossophora.

Dentalium attenuatum Say.
Cadulus thallus Conr. sp.
Chiton transenna H. C. Lea.
Fissurella catilliformis Rogers.
Adeorbis concava H. C. Lea sp.
(= Delphinula lipara H. C. Lea.)
Teinostoma subconica H. C. Lea sp.
Delphinula costulata H. C. Lea.
Trochus torquatus H. C. Lea.
(= Trochus Ruffini H. C. Lea.)
Trochus lens H. C. Lea.
(= Delphinula trochiformis H. C. Lea.)
Natica sphærulus H. C. Lea var.
Crucibulum grande Say.
(= Infundibulum concentricum H. C. Lea.)
Crepidula fornicata Lam.†

* See Proc. Acad. Nat. Sci. Phila., 1884, p. 108.

† Most of the species of Crepidula, described from the Atlantic Miocene, if not all of them, are apparently synonyms of this form. It is very variable and specimens of different age, shape and ornamentation have received specific names.

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Turritella terstriata Rogers.
Turritella quadristriata Rogers.
Turbonilla exarata H. C. Lea sp.
Turbonilla daedalea H. C. Lea sp.
Turbonilla eburnea H. C. Lea sp.
Turbonilla subula H. C. Lea sp.
Odostomia granulata H. C. Lea sp.
Eulima eborea Conr.
(= Pasithea lævigata H. C. Lea.)
Cerithiopsis clavulus H. C. Lea sp.*
(= Cerithium annulatum Emmons.)
Oliva ancillariæformis H. C. Lea.
Tornatina Wetherilli J. Lea sp.
(= Tornatina cylindrica Emmons.)
Bulla subspissa Conr.

Balanus concavus Bronn.

A tergum of a Lepadide, apparently of Scalpellum magnum Wood, Darwin, unfortunately was lost, together with a very minute specimen of an Ostracod, Cythere sp. No species of an Ostracod has been found heretofore in the Atlantic Miocene. Scalpellum magnum,† however, has been found at Petersburg, Va., but misinterpreted. The carina has been described by H. C. Lea as Patella acinaces,‡ and the scutum as Avicula multangula,§ and these species appear in the Miocene lists of Conrad‖ and Meek.¶ Prof. A. Heilprin, in his list of Tertiary fossils from Virginia, also enumerates Patella acinaces,** while Avicula multangula is put among those species of H. C. Lea which are "based upon young shells, or upon such as barely admit of characterization. ††

As my opinion about these fossils differs so essentially from that of a number of authors, I consider it necessary to give the figures of the type-specimens in the collection of the Academy of Natural Sciences in Philadelphia (Fig. 11, 11*a*, 12, 12*a*), so that others may be able to form their own judgment. The original figures of H. C. Lea are not sufficient for this purpose.

* One of my specimens has three embryonic whorls preserved. They are smooth and this apparently shows that the species is not identical with the Eocene Cerithiopsis constricta H. C. Lea sp., although adult specimens without nucleus look alike. See Berichte d. Senckenberg. Naturf. Gesellsch., Frankfurt a. M., 1887, p. 8, Pl. 2, fig. 23; and see Proc. Acad. Nat. Sci. Phila., 1884, p. 105.

† Darwin, fossil Lepadidæ, p. 18, Pl. 1, fig. 1.

‡ Trans. Amer. Philos. Soc., Vol. ix, p. 247, Pl. 35, fig. 36.

§ *Ibid.*, p. 245, Pl. 35, fig. 31.

‖ Proc. Acad. Nat. Sci., 1862, p. 570, p. 579.

¶ Smithson. Miscell. Collect., 183, Nov. 1864, p. 14; p. 6.

** Contrib. to the Tertiary Geol. and Palæont. of the U. S., p. 57.

†† *Ibid.*, p. 48.

II. Species New to the American Tertiary.

Cœcum stevensoni n. sp. Figure 4.

Relatively large; regularly and well curved. Shell thick. Surface closely covered by strong longitudinal costæ, which are usually alternating. Septum mucronate.

If the shell is kept horizontal, its convexity towards the observer, the mucronation of the septum appears on the left side. Its size and position is variable, sometimes it is nearly marginal, sometimes subcentral. The costæ are usually broader than the interstices between them and alternating, but in some specimens they are nearly equal. The younger part of two specimens shows indications of rings, producing a very slight cancellation. There is a contraction at the aperture, but it is confined to the margin of the aperture and nearly imperceptible. Besides the regular form there occur smaller specimens of equal ornamentation, but different shape. They have a less cylindrical tube, the increase in width towards the aperture being much larger. The same small and tapering form occurs with the following species. Wood observed the same form occurring with the Crag species of Cœcum. He considered them at first as distinct species, and then described them as varieties (see Crag Mollusca, Vol. i, p. 116, Pl. 20, fig. 4*b*). I think they are the adolescent state of the species.

I have not become aware of a form of the European Tertiary, with which to compare C. stevensoni, and no costated Cœcum is known from the American Tertiary. Specimens of the recent Cœcum cooperi Smith were compared and proved to be somewhat similar, but specifically different. They have fewer and thinner ribs, are distinctly cancellate and have a different shape. C. stevensoni is quite common in Yorktown.

Cœcum virginianum n. sp. Fig. 3.

Relatively large; regularly but slightly curved. Shell thick. Septum prominent, angular. Surface smooth, with concentric striæ of growth.

The mucronation of the septum is situated and is variable, like in the preceding species. Specimens of the adolescent state have a more tapering form, as in the preceding species.

A similar European fossil is apparently Cœcum mammillatum Wood,* from the Crag; which, however, is more curved and has a less angular and more mammillated septum. About the differences with other smooth species of the American Tertiary see below. Similar recent species are apparently Cœcum chinense de Folin† and Cœcum læve Adams.‡ I have not been able to compare specimens of these two species. C. chinense, according to De Folin's figure, seems to be more slender and more tapering and the septum seems to be different. C. læve is described as shining and is apparently a shorter species.

* Wood, Crag Mollusca, Vol. i, p. 116, Pl. 20, fig. 4.

† De Folin, Fonds de la mer, Vol. i, p. 80, Pl. 9, fig. 3-4.

‡ See Tryon's Manual of Conchology, Vol. viii, p. 215, Pl. 66, fig. 52.

Cæcum glabrum Montague var. Fig. 5.

Dentalium glabrum Mont., Testacea Britannica, p. 497.

Small; regularly curved; cylindrical surface smooth, shining. Septum not prominent, convex, very slightly mucronate.

Those specimens of the recent C. glabrum which I was able to compare had a septum as regularly curved as a watch glass and without any mucronation. The septum of the Yorktown specimens, however, though at first sight also regularly convex, shows at a closer examination in nearly all cases a slight mucronation, and for this reason I consider it necessary to call the Yorktown specimens a variety. The Crag species which Wood described as C. glabrum* resembles perhaps more to this Miocene form than to the recent one. C. glabrum is not rare in Yorktown.

The following is a brief review of the species of Cæcum known as yet from the American Tertiary:

Eocene.—1. Cæcum solitarium Mr.,† Vicksburg, Miss., of middle size, regular curvation, smooth surface and contracted at the aperture. 2. Cæcum alterum Mr.,‡ Jackson, Miss., similar to the preceding, but slightly annulated.

Miocene.—3. Cæcum annulatum Emmons,§ North Carolina. A specimen is in the collection of the Academy. It is very strongly annulated. 4. Cæcum stevensoni Mr., Yorktown, Va., coarsely costated. 5. Cæcum virginianum Mr., Yorktown, Va., smooth, large, thick, rather straight, septum prominent and angular. 6. Cæcum glabrum Mont. var., Yorktown, Va., smooth, small, thin, curved with flattened septum.

Pyramis promilium n. sp. Fig. 1.

Small, subulate. The dextral nucleus is followed by five adult whorls. They are somewhat convex, ornamented by revolving punctuate striæ, about four on each whorl. Base rounded, covered by similar striæ. Mouth oval. Inner lip with a small receding fold. Outer lip thin.

The figured specimen is not entirely adult and though not specifically different differs somewhat from the rest. It is less slender and the only one in which the punctuate nature of the revolving striæ can be distinctly recognized. The fold on the columella is hardly perceptible when the mouth is perfect, as in the type-specimen, but is more conspicuous in broken specimens.

While in the Yorktown material most of the small species described by H. C. Lea from Petersburg, Va., were found, Actæon milium H. C. Lea was not detected. But, as it were in place of it, above similar species occurs. At first sight Actæon milium seems to be very different, because it has a stout form and a stronger fold. The amount of slenderness, how-

* Crag Moll., Vol. i, p. 117, Pl. 20, fig. 6.
† Bull. i, Geol. Survey Ala., p. 68, Pl. 3, fig. 9.
‡ Ber. d. Senckenberg. Naturf. Gesellsch., 1887, p. 6, Pl. 1, fig. 8.
§ Emmons, Geology of North Carolina, p. 274, fig. 190.

ever, seems to be not quite constant, and the species are apparently allied. The only similar recent shell seems to be Pyramis striatula Couthouy* (= ? Menestho albula Fabr.), which form, however, is much larger and without visible fold, apart of other differences.

Turbonilla paucistriata ? Jeffreys. Fig. 2.

? Odostomia paucistriata Jeffreys ; Proc. Zoöl. Soc., London, 1884, p. 361, Pl. 27, fig. 6.†

The sinistral nucleus, which is twisted outwards, is followed by five adult whorls. They are flattened and covered by broad, flat, straight ribs, about fifteen on the last whorl. Suture impressed. Base rounded, smooth. Mouth pear-shaped. Outer lip thin.

The interstices between the ribs are mere furrows. On the younger whorls these furrows are not equal and not regularly arranged. Only two specimens were found, and they are, probably, not quite adult. The figured one has a volution less than the other, but a perfect mouth.

Turbonilla exarata H. C. Lea sp., of the same locality, is less slender, its whorls are more convex and the ribs are strong and obliquely set. Turbonilla subula H. C. Lea sp., of the same locality, is considerably stouter, has convex whorls and strong ribs. Turbonilla eburnea H. C. Lea sp., of the same locality, has sharply cut revolving striæ between the ribs. The form agrees with the description and figure of T. paucistriata Jeff., but I have not been able to compare specimens of this recent species and therefore am not entirely certain about this determination.

Astarte orbicularior n. sp. Fig. 6.

Shell, thick, flat. Suborbicular, umboneal margins more or less straightened, ventral margin rounded. Beak very small, medial. Lunule flat, lanceolate. Hinge broad, cardinal teeth strong. Muscular impressions suboval, about equal, anterior one with separate auxiliar. Margin entire. Surface smooth or with a few concentric undulations.

The species is flatter and more orbicular, than any one that has been described from the Atlantic Miocene. It is variable in form and young specimens are more convex, more trigonal, and the beak is turned more

* Boston Journ. Nat. Hist., ii, p. 101, Pl. 1, fig. 6, and Gould, Invert. Mass., p. 269, fig. 174.

† J. G. Jeffreys, On the Mollusca procured during the Lightning and Porcupine Expedition. On page 364 the genus Mathilda is placed in the Pyramidellidæ. I considered this position of Mathilda probable in the Berichte d. Senckenberg. Naturforsch. Gesellsch., 1887, p. 6, without having been aware, at that time, that Jeffreys pronounced the same idea in 1884.

On page 365, Pl. 27, fig. 10, Jeffrey's describes the new genus Gegania. I am not aware of any generic difference of this genus and Tuba J. Lea, and the recent Gegania pinguis Jeffreys, and the Eocene Tuba striata J. Lea (Contrib. to Geology, p. 128, Pl. 4, fig. 117) seem to be rather allied species.

distinctly anteriorly. They approach in their form Astarte coheni Conr.* and Astarte symmetrica Conr.† and indicate that the species has been derived from the usual trigonal form of Astarte. A similar recent shell, judging from the figure, seemed to be Astarte quadrans Gould,‡ but a comparison of specimens proved that there is no resemblance.

Leda pygmæa ? Muenster. Fig. 7, 7*a*.

?Nucula pygmæa Muenster, Goldfuss, Petref. German. Vol. ii, p. 157, Pl. 125, fig. 17.

Small; triangularly ovate; subequilateral. Without distinct lunule or corselet. Shell rather thick. Hinge broad, with about fourteen teeth altogether. Pallial sinus small. Surface smooth.

Only the figured specimen was found and no opportunity has yet been found to compare it with the German typical specimens. What Wood describes as Leda pygmæa Muenst. from the Crag§ has been separated by Weinkauff‖ from the German species and identified with the recent Leda tenuis Philippi.¶ It seems to have a thinner shell and more teeth than the German Oligocene form. The Yorktown specimen has a solid shell and relatively few teeth.

Modiolaria petagnæ Scacchi. Fig. 8.

Modiola Petagnæ Scacchi, Philippi, Enum. moll. Sic. Vol. ii, p. 51; Vol. i, Pl. 5, fig. 11.

Oblong; ventricose; angular posteriorly. Anterior side contracted, extending beyond the umbo. Anterior and posterior surface radiately ribbed, the ribs decreasing in size towards the middle and not existing on the middle. Whole surface moreover irregularly concentrically striated. The radiating ribs crenulate the inner margin. Inside somewhat nacreous.

Both the concentric and radiating ribs are not regularly arranged, taking their origin by bifurcation of other ribs. By the crossing of the ribs the anterior and especially the posterior surface appear cancellate.

The shell agrees with the Crag form, which Wood described as Modiola costulata Risso,** comparing it with the figure of Philippi in the Enumeratio molluscorum Siciliæ, Vol. i, p. 70, Pl. 5, fig. 11, referred by Philippi himself in Vol. ii, p. 51, to M. petagnæ Sc. But Wood considered M.

* Conrad, Mioc. Fossils, p. 43, Pl. 21, fig. 5.

† *Ibid.*, p. 44, Pl. 21, fig. 7. I have seen specimens labeled with Conrad's handwriting "Astarte coheni," but with entire margin, while he describes this species with crenulated margin, like A. symmetrica. Altogether I am not aware of any specific difference between the two forms, even if the margins should differ.

‡ Gould, Invert. Mass., p. 81, fig. 48.

§ Crag Moll., Vol. ii, p. 95, Pl. 10, fig. 11.

‖ Weinkauff, Conchilien d. Mittelmeeres, Vol. i, p. 211.

¶ Phil., Enum. Moll. Sic., Vol. i, p. 65, Pl. 5, fig. 9.

** Crag. Moll., p. 60, Pl. 8, fig. 6.

costulata and M. Petagnæ only as varieties of the same species. A comparison of specimens of the two recent forms, however, convinces me, that they are different, and this is apparently the general opinion. The Yorktown form agrees specifically with specimens of M. Petagnæ from Greece, and agrees in every detail with specimens of M. Petagnæ from the Canary islands. The recent M. lateralis Say, though generally stouter, is similar and perhaps might be united with M. Petagnæ.

Modiola phaseolina Philippi. Fig. 9.

Philippi, Enumer. mollusc. Sic., Vol. ii, p. 51, Pl. 15, fig. 14.

Nacreous. Oblong-ovate. Ventral margin straight or subsinuated, dorsal margin subangulated. The small cardinal area is finely striated and the interior part of the dorsal margin is minutely crenulated within. Surface with striæ of growth.

Modiola ducatelli Conr.* from the Atlantic Miocene is a large, elongated and flattened species of apparently very different form. The type and only specimen has only the outside exposed so that interior characters cannot be determined. More similar seems to be Modiola inflata Tuomey & Holmes.† But this species is founded on a single and incomplete impression and I am unable to determine its specific characters. The Yorktown specimens agree with Philippi's description and figure of M. phaseolina from the Crag‡ and with recent specimens from the coast of England.

Semele ? virginiana n. sp. Fig. 10, 10*a*.

Only the figured right valve of this form has been found. As the shell is solid, the adductors are well marked and the pallial line very strongly impressed, I think the specimen is adult, or at least adult enough to show its generic and specific characters. Its main peculiarity is the position of the cardinal teeth, which are not below the beak. Altogether I do not think that the shell can be properly placed into the genus Semele or any other existing genus, but it may be named this way until more material is found. It may be described in the following way.

Minute; compressed; not gaping. Subcuneiform, posterior side short, beak being rather terminal. Anterior margin regularly rounded, posterior margin truncate. Anterior muscular impression orbicular, sinuated anteriorly; posterior muscular impression elongated, sinuated posteriorly. Pallial sinus deep. Below the small beak there is a subquadrangular cartilage pit, anterior to which there is vertical and rather strong cardinal tooth. A second cardinal tooth adjoins it, which is obsolete, oblique and formed by a slight increase of the continuation of the anterior lateral tooth. Lateral teeth strong; the anterior one is long, the posterior one of

* Conrad, Mioc. Foss., p. 53, Pl. 28, fig. 2.
† Pliocene Foss. South Carolina, p. 33, Pl. 14, fig. 3.
‡ Crag Moll., p. 59, Pl. 8, fig. 4.

about half its length. Surface regularly, closely and strongly concentrically ribbed, the ribs disappearing near the umbo. Lunule small; indistinct.

Miliolina seminulum Linné sp.

One specimen has been found only and has been determined as above by Mr. A. Woodward, in New York. Though no foraminifera is mentioned in Meek's Miocene Check List (Smithsonian Miscellaneous Collections, 1864), J. Lea has described a species from the Miocene of Maryland as Miliola marylandica,* and it is very probable that this name is a synonym of above.

EXPLANATION OF PLATE.

Fig. 1. Pyramis promilium n. sp. ..... Yorktown, Va.
" 2. Turbonilla paucistriata ? Jeffreys..... " "
" 3. Cæcum virginianum n. sp..... " "
" 4. Cæcum stevensoni n. sp..... " "
" 5. Cæcum glabrum Montague var..... " "
" 6. Astarte orbicularior n. sp..... " "
" 7, 7a. Leda pygmæa ? Muenster..... " "
" 8. Modiolaria petagnæ Scacchi..... " "
" 9. Modiola phaseolina Philippi. ..... " "
" 10, 10a. Semele ? virginiana n. sp..... " "
" 11, 11a. Carina of Scalpellum magnum..Petersburg, Va.
(type of Patella acinaces H. C. Lea.)
" 12, 12a. Scutum of Scalpellum magnum.. " "
(type of Avicula multangula H. C. Lea.)

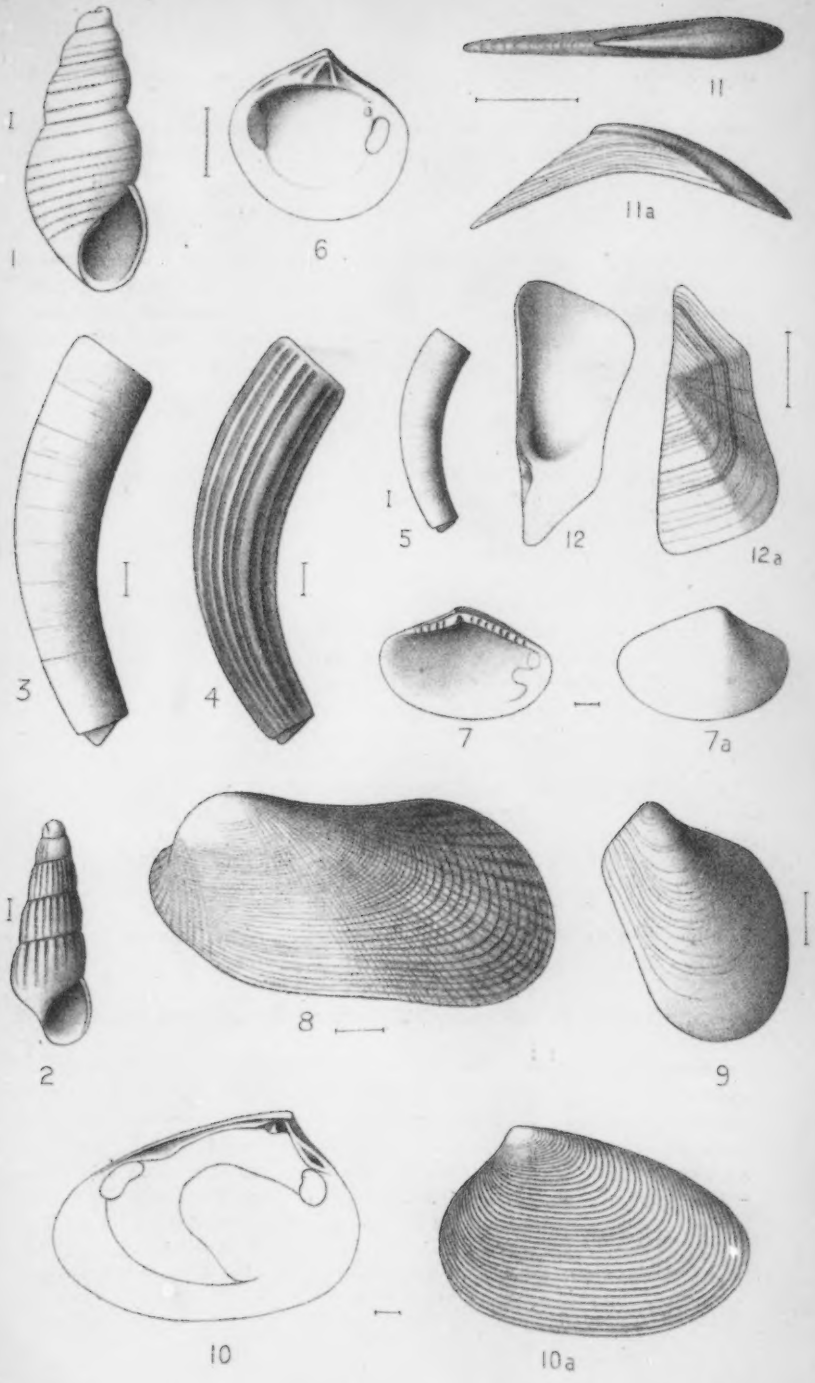
On some Possible Methods for the Preparation of Gramophone and Telephone Records. By Prof. Edwin J. Houston.

(Read before the American Philosophical Society, April 20, 1888.)

Phonograph records, of the type employed by Mr. Berliner in his gramophone, *i. e.*, those obtained by causing the point or stylus attached to the vibrating diaphragm to move parallel to the recording-surface instead of perpendicular thereto, can be prepared more readily, and by a greater variety of methods, than is possible with record-surfaces of the old forms.

In a study of the later forms of phonographic apparatus, several methods of preparing gramophone plates have suggested themselves to the author, which he hopes soon to be able to put to the test of actual trial. These methods, though particularly applicable to records horizontally traced,

* Contrib. to Geology, p. 215, Pl. 6, fig. 227.



O. Meyer, Del. MEYER—MIOCENE INVERTEBRATES J.W. Ross, Lith.

may, in certain cases, by slight modifications, be applied also to those vertically traced.

In order to place some of these methods on record, a brief description will be given of a few of the most promising. At the same time, the author admits that serious difficulties may lie in the way of practically carrying out some of the methods proposed.

Mr. Berliner, as is well known, prepares his record-surfaces by moving the tracing point over the surface of a plate of inked glass or metal, covered with a uniform deposit of lamp-black. The record thus obtained is either mechanically copied on a metal surface, or is reproduced thereon by the process of photo-engraving, or etching. I would suggest the following methods, viz.:

(1.) After the record on smoked glass is obtained in the usual manner, expose the plate to the action of a regulated sand-blast so as to obtain cuttings or groovings on the surface of the plate, suitable for the movements of the reproducing diaphragm. Roughness in the edges of the lines so obtained would probably cause screaming sounds in the words reproduced, which might be removed by a few applications of an emery-covered tracing point.

Should the action of the sand-blast remove the coating of lamp-black and ink on the covered portions of the plate, these portions might be rendered more adherent by the freer use of a more viscous ink, and the deposition of finer spiculæ of carbon.

(2.) The phonogram record-surface is composed of a smooth surface of hardened wax, on a composition of wax and resin which is *locally heated* so as to *slightly soften the surface* directly under the tracing point or stylus.

In order to ensure the rapid cooling and hardening of the surface, immediately after the impression has been impressed thereon, the heating must be local and not general. To more thoroughly ensure local cooling, a light blast of cool air might be directed on the surface almost immediately after the tracing has been made. To prevent the air so applied from cooling the surface that is being warmed in order to receive the record, a suitably arranged diaphragm may separate adjacent cooled and heated portions.

(3.) Instead of heating the record-surface itself, a local source of heat may be used to heat the tracing point or stylus. This heat may be either ordinary heat, or that of electrical origin. When the stylus, instead of the record-surface, is heated, the latter may be made of much harder material.

Any tendency of the record-surface to run and thus mar the correctness of the recorded sounds, may be checked by the use of a properly directed blast of cold air as already suggested under (2).

It is evident that the use of cold air, or its equivalent, is much more suitable in this case than where the record-surface itself is heated.

Any tendency of the surface or tracing-point to clog may be remedied by suitably shaping the cutting-surface of the point, or the composition of

the record-surface, or the degree of temperature employed for the softening.

(4.) The record-surface consists of a glass plate covered with a thin layer of wax. Either the record-surface itself, or the marking stylus, is locally heated as before, only the layer of wax is so thin as to leave the glass exposed after the passage of the tracing-point. The cooling blast of air, and the separating diaphragm described in (3) are applicable to this process.

A permanent record is then etched in the surface of the plate so prepared either by the sand-blast process, or, preferably, by the action of hydro-fluoric acid.

Before the application of either the sand-blast or the acid, care should be taken to see that the lines traced are free from wax.

(5.) Instead of employing the records on the lamp-blackened glass surface as a photographic negative for the purpose of reproducing them by photo-engraving or etching, they may be used for transferring the record to a glass surface covered with a film of sensitized gelatine. The portions of the glass that are left uncovered after the plate is fixed are then deeply cut or etched by treatment with either gaseous or diluted liquid hydro-fluoric acid.

I have treated a gelatine-covered glass plate printed from a photograph by means of this process, and find that it produces a very fair and permanent picture on the glass.

It is evident that this process will leave the design either in relief or intaglio according as a photographic negative or positive is used.

(6.) The recording diaphragm, in its movements to and fro, is caused to deposit, on the surface of the record-plate, a uniformly thick line or layer of some rapidly hardening substance. This substance is contained in a vessel provided with a pointed outlet tube, and attached to the diaphragm. The material either runs out by its weight and is deposited on the record-surface, or is forced out by the movements of the diaphragm itself.

The substance may be rendered fluid while in the containing vessel by the action of heat, hardening on cooling, which latter may be hastened by a suitably directed blast of cooled air.

A record, thus prepared, would consist of a uniformly thick, sinuous ridge of the hardened material. The reproducing stylus, or that giving motion to the diaphragm that reproduces the speech, could, it is evident, be operated either from the upper or the lower surfaces of the sinuous ridge independently, or from both simultaneously.

(7.) If the movements of the receiving diaphragm of a telephone be sufficiently amplified or intensified to permit it to trace or cut a sinuous record on a suitably prepared record-surface by any of the methods proposed in this article, or by any other method, then there would be produced a simple, yet effective method for obtaining not only a permanent record of a telephonic dispatch, but as well a means of reproducing it as often as might be desired.

Success could hardly be looked for by means of any device that left the record on the record-surface by movements at right angles thereto; for, since the movements of the telephone diaphragm are exceedingly minute, and the amount of energy represented thereby exceedingly small, it is hardly to be expected that a record of any value could be so produced. But with a record recorded by movements parallel to the surface, and received on a surface whose resistance to motion is small, the difficulties would not appear to be insurmountable.

It should be carefully borne in mind that a telephone record may be made of very small dimensions. Indeed, in the case of any phonographic apparatus, where it is not intended that the record should reproduce the sounds by direct mechanical movements of the diaphragm, large records are not always necessary nor are they even desirable; for, such reproduction may be effected electrically.

Where the telephone record-surface has been prepared, no effort should be made to cause it to reproduce the telephonic despatch mechanically. *An electrical method of reproduction is far the preferable one.*

(8.) The following method would appear to promise excellent results. Employ the telephone-record to act mechanically on a lever or other device, but instead of attempting to cause the movements of such a lever to impart audible, articulate motion to a receiving diaphragm, cause them to act directly on a variable resistance in the circuit of which is included a voltaic battery and a receiving telephone. Since, for such an operation, very slight movements of the variable resistance contacts are required, it is by no means improbable that some of the methods proposed, or, obvious modifications thereof, will, in practice, be found applicable for the production of a permanent telephone record.

The advantages of a telephonic record thus obtained arise not only from its permanency, but also from the possibility of preparing a phonographic record of the voice or message, and sending the same for telephonic transmission over a line to a distant point.

(9.) Before concluding this brief sketch, it might be well to suggest the following plan, which would appear to be particularly suitable for obtaining a telephone record: Mount a concave mirror at the centre of the diaphragm of the receiving telephone; or, better yet, from the entire diaphragm of a concave mirror, shaping the magnet pole of the telephone to conform to the approximated surface thereof. When the telephone is receiving transmitted speech, allow the light reflected from the diaphragm-mirror, and suitably concentrated by a lens, to fall on a sensitized photographic plate placed in a plane at right angles to the plane of the diaphragm, so as to receive the spot of light parallel to its surface. The photographic plate must, of course, be moved mechanically at right angles to the direction of movement of the spot of light. The plate thus acted on is then developed, fixed, and used to reproduce the record by any of the well-known methods of photo-engraving, etching, etc. The record thus obtained may be used either mechanically to reproduce the trans-

mitted speech in an ordinary phonographic apparatus, or, preferably in connection with a variable resistance contact, electrically in a receiving telephone.

There can be no doubt, whatever, that this method will be found operative in practice, since the engraving stylus, a pencil of light, is destitute of weight, and therefore offers no resistance to the free movements of the telephone diaphragm.

(10.) Instead of causing the voice, as in the ordinary form of phonographic or gramophonic apparatus, to act mechanically on the record-surface, cause it to move a suitably focussed pencil of light over the surface of a photographic plate. A very complete record could thus be obtained, in which it would be possible to impress on the plate all the minute peculiarities of the overtones, on which the quality of the voice depends. In this manner there could be obtained and preserved records of the voice of distinguished individuals.

The photographic method just described would possess, among others, the following advantages, viz.:

1st. The ease with which it could accurately reproduce in all their minutiæ the tones involved in the production of articulate speech.

2d. The readiness with which such a record could be magnified to any desired extent, thus rendering possible an increase in the amplitude of the reproduced vibration.

3d. The aid such magnified, accurate sound-records would afford in the study of the same with a view, not only of ascertaining their peculiarities, but even with a view of being able to read articulate speech directly from the diaphragm record.

CENTRAL HIGH SCHOOL,
PHILADELPHIA, *April 6, 1888.*

Stated Meeting, April 20, 1888.

Present, 14 members.

President, Mr. FRALEY, in the Chair.

Correspondence was submitted as follows:

A letter from Washburn College, Topeka, Kansas, requesting exchanges; on motion, ordered to receive Proceedings from No. 96.

A letter from Prof. Joseph Prestwich, with change of address (Shoreham, Sevenoaks, Kent).

A letter of envoy from the Meteorological Office, London.

Letters acknowledging receipt of Proceedings, No. 126, from Sir William Thompson, South Kensington Museum (London) and M. Claudio Jannet, Paris.

The President reported that he had received letters in response to the circular in reference to a Congress to consider the question of an International Language, from James M. Taylor, President of Vassar College, Poughkeepsie, N. Y.; D. C. Gilman, President of Johns Hopkins University, Baltimore, Md.; Prof. W. LeConte Stevens, Brooklyn, N. Y.; Prof. B. L. Gildersleeve, Baltimore, Md.; President of the University of South Carolina; Director of the U. S. Nautical Almanac.

Accessions to the Library were received from Prof. George Bauer, Agram, Austria; Prof. P. Steiner, Darmstadt; Naturwissenschaft Verein, Frankfurt, a. O.; Geographische Gesellschaft, Hanover; Prof. Giuseppi Sergi, Rome; R. Academia di Ciencias, Madrid; Rousdon Observatory, Devon; Meteorological Council, British Association, Dr. B. W. Richardson, "The Earth," London; Historical and Scientific Society of Manitoba, Board of Trade, Winnipeg; Archæological Institute of America, Boston; Museum of Comparative Zoölogy, Cambridge; R. I. Historical Society, Providence; New York State Museum of Natural History, Albany; Buffalo Historical Society; Academy of Sciences, Prof. J. S. Newberry, New York; Mr. W. J. Potts, Camden; Geological Survey of New Jersey, Trenton; University of Pennsylvania, Mercantile Library, Profs. Lewis M. Haupt, Edwin J. Houston, Messrs. Henry Phillips, Jr., Richard Vaux, Com. E. Y. McCauley, Philadelphia; Departments of Justice, State and the Interior, Captain John G. Bourke, Washington, D. C.; University of Virginia; Prof. N. H. Winchell, St. Paul; California Academy of Sciences, San Francisco; Prof. Mariano Bárcena, Mexico.

The President stated that pursuant to the resolution of the Society, he had appointed P. DuBois, Esq., to prepare the obituary notice of Prof. James Curtis Booth, and Dr. John A. Ryder that of Joseph Zentmayer, and that they had accepted the appointments by letter.

Prof. Houston presented a communication on Some Possible

Methods for the Preparation of Gramophone and Telephone Records.

Mr. Phillips exhibited some specimens of *Physa heterostropha* found in water from the pipes of the drinking supply furnished by the Schuylkill river this and last Spring.

Prof. Houston and Dr. Morris spoke in relation to the impurity and insufficiency of the water supply of the city.

The President referred to the volume and condition of the water passing over the Fairmount dam, stating that the area of the pool has diminished but very little in later years, and that in his opinion the drinking water of the city was as pure as that supplied to New York and better than that to Boston. The President stated that he possessed a manuscript essay by Henry Campbell, C. E., of this city, containing a project for supplying City of New York with water by putting a very high dam some distance above the city, so as to prevent the salt water running up, and thus utilizing all the fresh water supplied by the Hudson river.

For Philadelphia, he proposed to collect the rain water in tanks and distribute it as needed.

Dr. J. Cheston Morris said that perhaps the supply water-pipe referred to by Mr. Phillips contained some bend in which the ova lodged and were hatched from time to time—the ova subjected to heat in the hot water-pipe being killed. Observation of our ordinary Schuylkill supply would soon satisfy one of the frequent existence in it of many forms of animal life. We greatly need in this city sufficient reservoirs for subsidence; our supply would then be comparatively good, and free from much of the present cause of complaint. The scouring of the pools and basins of the dams of the Schuylkill, which occurs during the freshets, would then remove much noxious material.

Prof. Houston having suggested the great lakes as probably a good future source of supply for our Eastern cities, Dr. Morris said, the results of their employment at Chicago were not such as to encourage us. And New York would hardly like to take the Erie canal as its source.

A serious question is that of change occurring in waters long impounded in reservoirs; but he believes, with Mr. E. F. Smith, that the waters of such reservoirs drawn from a distance of at least six or eight feet below the surface and as much above the bottom, so as to avoid the confervoid and bacterial growths near the surface, and the organic remains of previous life which settle to the bottom, would give the best results attainable. It has been shown also, by experience, that water contaminated with organic matter has a tendency to purify itself, in rapidly flowing streams interrupted by cascades or riffles, by the growth of animals and plants of the lower orders. While speaking on the subject, he would allude to the excellent character of the water supply from the Schuylkill as to its solid ingredients. Water may be too pure, *i. e.*, deficient in those salts and earthy matters which tend to maintain tissue-metamorphosis and growth; lime salts in moderate quantity are beneficial, while magnesian are irritant, purgative and unsatisfying to the thirst—as are the waters of the Paris basin—while excess of lime salts, as in the Mississippi Valley, gives rise to calculous concretions. Many diseases can thus be traced to defective water supply.

The greater amount of organic matter in the water of the upper Delaware is the result of its drainage from the swamps and vegetable decaying matters on the mountains above the Water Gap. Much of the impurity of the Schuylkill is gotten rid of in the precipitation which occurs in its course from the traversing by its waters, acidulated from the mines, of the limestone bed of rocks above Reading.

Mr. McKean was of the opinion that the assumption, because there is some albuminoid matter in the water we get from our hydrants, it is therefore unwholesome, was unfounded. He was doubtful if it had been made clear that the *albuminoids* and other matters presumably unwholesome, found in the supply of drinking water as furnished to us, are really unwholesome unless accompanied by antecedent extraneous fever germs. He adverted to the low death-rate of London and Philadelphia as militating against the theory of the great unwholesomeness of their drinking water.

In reply to a question by Mr. McKean, as to the proof of disease resulting from waters containing ammonia, Dr. Morris said we should carefully distinguish between albuminoids, and albuminoid ammonia and free ammonia. No one would doubt the unhealthiness of water contaminated with decaying or putrescent albuminous matters. The amount, however, of albuminoid and free ammonia—with the chlorides and nitrites—enables us to trace the previous life history of the water. As to such a supply being injurious to health, the record of the U. S. Army during operations along the Chickahominy, and the experiences of Dr. Livingstone and Stanley in Africa, afforded the illustrations required.

Dr. Kœnig was of the opinion that the Schuylkill water was very much abused and was better than it looked. Its looks could be easily remedied by filtering. The substances in solution in Summer and Winter only differed by a *few milligrams to the litre.* The purifying action of the forebay was very great; that there was no appreciable difference in free ammonia above and below the dam.

Dr. Kœnig believed that the danger of infection from disease germs from fecal matter in running water was very much overrated.

Dr. Horn and Mr. Burke also spoke on the subject.

The *Ives' Stratigraphic Geological Map* was exhibited and explained to the Society.

Pending nominations Nos. 1176, 1177, and 1178, and new nominations Nos. 1179 and 1180 were read.

The Committee on the Library reported having held a full meeting and having agreed on the purchase of a number of Encyclopedias, Dictionaries, etc., and works of reference, as ordered by the Society.

On motion, the Society authorized the construction of book-cases to contain these works of reference, at a cost not to exceed $50.

The Publication Committee reported having authorized the publication of Prof. Cope's papers on the *Eryops* and on the *Puerco Fauna*, and that the same would finish the second part

of the XVIth Volume of the Transactions, which would then be issued.

The President reported that he had received and paid over to the Treasurer $132.76, the quarterly interest due April 1, 1888, on the Michaux Legacy.

And the Society was adjourned by the President.

Stated Meeting, May 4, 1888.

Present, 29 members.

President, Mr. FRALEY, in the Chair.

Prof. W. P. Wilson, a lately elected member, was presented to the Chair, and took his seat.

Correspondence was submitted as follows, viz.: Program of the Annual Poetic Contest for the Prizes awarded by the Academia Regia Nederlandica.

Letters of envoy from Société de Litterature Finnoise, Helsingfors; K. Sächsische Gesellschaft der Wissenschaften, Leipzig.

Letters of acknowledgment from Société Royale des Sciences de Liège; Prof. G. Sergi, Rome; Radcliffe Observatory, Oxford, England; Buffalo Library (126); Newberry Library, Chicago; Elisha Mitchell Scientific Society, Chapel Hill, N. C. (96–126); Prof. C. V. Riley, Washington, D. C. (119).

The President reported that he had received, in answer to the proposed invitation for a congress to consider the project of an international scientific language, letters from Institute of Technology, Boston, Mass.; W. E. A. Axon, Manchester, England; Dr. L. Samenhoff, Warsaw, Russia; Yorkshire Geological and Polytechnic Society; Dr. F. S. Krauss, Vienna, Austria.

Accessions to the Library from Prof. G. vom Rath, Bonn; K. Nordiske Oldskrift-Selskab, Copenhagen; "Flora Batava," Leiden; Nederlandsche Bontanische Vereeniging, Nijmeguen; R. Academia de Ciencias, Madrid; R. Meteorological, R. Astronomical Societies, London; Canadian Institute, Mr. James T. V. Ives, Toronto; Society of Civil Engineers, Boston; Providence Public Library; American Oriental Society, New Haven; Buffalo Library; New York Meteorological Observatory; Messrs. William Harden, B. S. Lyman, Henry Phillips, Jr., Philadelphia; Light House Board of the United States, Washington, D. C.; Prof. John C. Branner, Little Rock, Ark.; University of Michigan, Ann Arbor; Iowa State Historical Society, Iowa City; University of California, Berkeley; Direccion General de Estadistica, Guatemala, S. A.

The Committee appointed December 16, 1887, to prepare the Magellanic Medal, reported that the same was now ready and delivered it to the President, who gave it to Prof. L. M. Haupt with the following address:

"Prof. Haupt, it is a great gratification to me, both personally and officially, to present to you the Magellanic Premium, which has been awarded by the American Philosophical Society for your essay on 'The Physical Phenomena of Harbor Entrances, their Causes and Remedies.' This essay treats of matters of great national importance, and your discussion of them will greatly tend to the improvement of the methods now in use for effecting the permanent removal of the obstacles in our harbors and rivers, which are so dangerous to navigation and are so full of risk to the lands and buildings along their shore-lines. A glance at the map of the United States will show the great number of our navigable rivers and the vast extent of coast-lines, and their valuable and important harbor entrances. And it is therefore important that the money appropriated for their improvement and enlargement shall be wisely and scientifically expended. I think your suggestions will be found very valuable in securing stability to all artificial structures that may be erected in our great waters for their protection and convenient use, and you are therefore entitled to be honored as a public benefactor. The Magellanic Premium was established in the year 1786, and the records of the Society show that only six awards of the medal and one honorary pecuniary premium have been made within the century. Yours is therefore the seventh premium. It is thus shown that the terms under which the premium can be claimed are difficult to be

met, but you have filled them, and I sincerely and cordially congratulate you on your success."

Prof. Haupt made the following reply:

"Mr. President and fellow-members of the American Philosophical Society:—Accepting this estimable token of approval, which this distinguished Society has conferred upon the results of my investigations, it gives me great pleasure to express to you my grateful obligations for this unusual mark of approbation.

"The conditions accompanying applications for the Magellanic Premium being such as to eliminate entirely all personal elements, I felt that the opportunity of obtaining a critical and impartial investigation of my researches was thus admirably presented, and that no more competent body, organized for scientific research, could be found to pass judgment upon a matter which I deemed of great importance to the commercial, scientific and engineering development of our country.

"I was pleased, therefore, to embrace this opportunity of presenting the paper on 'The Physical Phenomena of Harbor Entrances' to the American Philosophical Society for consideration and action. Whatever value the paper may have, and the weight and influence it may exert in the future, in modifying the plans for meeting the difficult requirements of maritime works, are chiefly due to the careful and deliberate consideration which your Society and committees have given to the subject; and, deeply as I feel the honor, as well as the responsibility, which this approval of my labors places upon me, I earnestly hope you will permit me to state that, whatever may be my share of the merit conferred, it is but the reflection of that emanating from yourselves as members of this learned Society.

"To me your endorsement is at this time particularly encouraging, for already I find myself in the position of the pioneer who breaks loose from the well-trodden highways and seeks to discover a new path through the trackless waste. His task is full of responsibility, and he needs to keep well in view his landmarks; sometimes ahead, at others behind him. So I find myself looking back for my bearings whilst I am pressing forward toward the goal, which is the introduction of these plans at some suitable port of entry along our coast.

"The difficulties which I expected to find, and do find, in this effort are those resulting from conservatism and inertia of the Government machinery; but they are inherent to all development and furnish additional evidence of the soundness of the conclusions you have already reached. It is, therefore, with peculiar satisfaction that I look upon this medal, the seal of your approbation, not as upon an *ignis fatuus*, to lure me on to destruction, but as a talisman to encourage me in pursuing the way I have taken as one leading to a laudable end.

"The discussions, which opposition must provoke, should result in elucidating more clearly the principles embodied in these physical studies and in removing them more and more from the domain of theory and planting them upon the firmer foundations of fact.

"By this means they will be brought to the knowledge of the unprofessional reader and receive the support of those most directly interested in their application.

"I have observed that in dealing with physical questions, involving only inert matter, the problems are comparatively simple, whilst those of a social character which enter the domain of mind become exceedingly complex, yet these two classes appear to be almost inseparably related. In developing an engineering project, the first stage is that of mental conception and evolution; the second, that of education and propagation; and the third, that of execution or construction. It is in the second stage where the greatest difficulties are encountered, for it is always a difficult task to undertake to modify prevailing impressions. The contest is an unequal one, but when the changes proposed are based upon and allied to Truth they must ultimately prevail. Otherwise, they must as certainly fail, and this is therefore the crucial stage.

"A distinguished philosopher says: 'The best way to come to Truth is to examine things as really they are, and not to conclude they are as we fancy of ourselves, or have been taught by others to imagine.'

"If we could but lay aside previous impressions and prejudices it would be an easy matter to apply this advice to see things 'as really they are,' but, unfortunately, judgment is too often blinded by habit or education. This prevalent propensity of accepting statements without investigation, or of reaching conclusions from superficial observations, has led mankind into many errors which can only be removed by searching and impersonal discussions. Such discussions, therefore, should be welcomed as tending to the perfection of knowledge and the revelation of Truth.

"The studies which I have submitted to you have been my recreation and delight, and in pursuing them I have realized the truth and beauty contained in these lines from 'Thalaba :'

> "'Learn thou, O young man,
> God hath appointed wisdom the reward of study!
> 'Tis a well of living waters,
> Whose inexhaustible bounties all might drink,
> But few dig deep enough.'

"The treasures of wisdom are only to be unearthed by digging deeply, and I believe it accords with the experience of every investigator, that the deeper he delves the more treasure he discovers. Especially is this true when applied to investigations relative to the laws of the physical world, and, as each increment of knowledge is added to that already gleaned, the mind of the devout student becomes more and more fully impressed with the sense of his own impotence and of the infinite majesty and wis-

dom of Him who, from the beginning, conceived, created and continually maintains the universe; to whom belongs all the glory, praise and honor of our feeble efforts forever.

"This idea of our dependence upon the Supreme Being your committee have very happily embodied in the motto which they have placed upon the medal: '*Non mutare Dei leges, sed in hominum usum adhibere.*'" *

On motion, the Society recommended that Prof. Haupt accede to the request of Messrs. Bailey, Banks & Biddle for a temporary loan of this medal, it being, according to their statement, the finest they have ever made.

The following communications were made for the Proceedings of the Society:

By Dr. T. Sterry Hunt, "On the Classification and Nomenclature of the Metalline Minerals."

By Dr. E. D. Cope, "On the Ear Bones of the Permian Batrachia."

Dr. Alfred Dugés (Mexico) presented through the Secretaries a paper on "Deux Especes Nouvelles des Ophidiens de Mexique."

* NOTE.—The Medal is of gold, oval in form, two and a quarter inches long by one and seven-eighths wide. The inscription (in alto-relievo) on the obverse is:

THE
PREMIUM
OF
JOHN HYACINTH
DE MAGELLAN,
OF LONDON.

Around the margin and separated from the panel by a heavy laurel wreath, is the motto prepared for the committee, which reads "*Non Dei leges mutare, sed in hominum usum adhibere.*"

On the reverse,

AWARDED
BY THE
AMERICAN
PHILOSOPHICAL
SOCIETY
TO
LEWIS M. HAUPT,
for his discovery in
Physical Hydrography
and for his invention of
a System of Harbor
Improvement.

Around the margin:

Philadelphia, Pennsylvaniensis,
December, MDCCCLXXXVII.

Prof. C. V. Riley referred to a possible error of transcription in the volume of Early Proceedings (No. 119) on pages 14, 15, as to the word *Hessian fly*.

On motion, the Committee on Hall was requested to consider the desirability of speedily procuring the fire-proof safe ordered by the Society on February 17, 1888.

The Society, on motion, approved the bill of Bailey, Banks & Biddle for $170, for the dies and metal of the Magellanic medal, and ordered that the same be paid.

Pending nominations Nos. 1176–1180 were read.

And the Society was adjourned by the President.

him the communication, description, or model, except the officer to whom it shall be entrusted; nor shall such officer part with the same out of his custody, without a special order of the Society for that purpose.

6. The Society, having previously referred the several communications from candidates for the premium, then depending, to the consideration of the twelve counsellors and other officers of the Society, and having received their report thereon, shall, at one of their stated meetings in the month of December, annually, after the expiration of this current year (of the time and place, together with the particular occasion of which meeting due notice shall be previously given, by public advertisement) proceed to final adjudication of the said premium; and, after due consideration had, a vote shall first be taken on this question, viz.: Whether any of the communications then under inspection be worthy of the proposed premium? If this question be determined in the negative, the whole business shall be deferred till another year; but if in the affirmative, the Society shall proceed to determine by ballot, given by the members at large, the discovery, invention or improvement most useful and worthy; and that discovery, invention, or improvement which shall be found to have a majority of concurring votes in its favor shall be successful; and then, and not till then, the sealed letter accompanying the crowned performance shall be opened, and the name of the author announced as the person entitled to the said premium.

7. No member of the Society who is a candidate for the premium then depending, or who hath not previously declared to the Society, that he has considered and weighed, according to the best of his judgment, the comparative merits of the several claims then under consideration, shall sit in judgment, or give his vote in awarding the said premium.

8. A full account of the crowned subject shall be published by the Society, as soon as may be after the adjudication, either in a separate publication, or in the next succeeding volume of their Transactions, or in both.

9. The unsuccessful performances shall remain under consideration, and their authors be considered as candidates for the premium for five years next succeeding the time of their presentment; except such performances as their authors may, in the meantime, think fit to withdraw. And the Society shall annually publish an abstract of the titles, object, or subject matter of the communications, so under consideration; such only excepted as the Society shall think not worthy of public notice.

10. The letters containing the names of authors whose performances shall be rejected, or which shall be found unsuccessful after a trial of five years, shall be burnt before the Society, without breaking the seals.

11. In case there should be a failure, in any year, of any communication worthy of the proposed premium, there will then be two premiums to be awarded the next year. But no accumulation of premiums

shall entitle the author to more than one premium for any one discovery, invention or improvement.

12. The premium shall consist of an oval plate of solid standard gold of the value of ten guineas. On one side thereof shall be neatly engraved a short Latin motto suited to the occasion, together with the words: "The Premium of John Hyacinth de Magellan, of London, established in the year 1786:" and on the other side of the plate shall be engraved these words: "Awarded by the A. P. S. for the discovery of———A.D.———." And the seal of the Society shall be annexed to the medal by a ribbon passing through a small hole at the lower edge thereof.

SECTION 2. The Magellanic fund of two hundred guineas shall be considered as ten hundred and fifty dollars, and shall be invested separately from the other funds belonging to or under the care of the Society, and a separate and distinct account of it shall be kept by the treasurer.

The said fund shall be credited with the sum of one hundred dollars, to represent the two premiums for which the Society is now liable.

The treasurer shall credit the said fund with the interest received on the investment thereof, and, if any surplus of said interest shall remain after providing for the premiums which may then be demandable, said surplus shall be used by the Society for making publication of the terms of the said premium, and for such purposes as may be authorized by its charter and laws.

The treasurer shall, at the first stated meeting of the Society in the month of December annually, make a report of the state of said fund and of the investment thereof.

☞ Members who have not as yet sent their photographs for the Society's album will confer a favor by so doing.

☞ Please communicate any change of address or inaccuracy in name.

☞ A few sets of the Society's Transactions, New Series, 1818 to 1883, XVI vols., 4to, can be obtained from the Librarian. Price, $80.00.